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THE GREEN-BUG (TOXOPTERA GRAMINUM ROND.) OUTBREAK OF 1916

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INTRODUCTION[1]

The green bug (*Toxoptera graminum*) occurred in destructive numbers in Kansas and Oklahoma in the spring of 1916. This insect has been fully discussed in Bulletin No. 2, volume 9, of the University of Kansas, and in Bulletin 110 of the Bureau of Entomology, U. S. Department of Agriculture. The history of this insect preceding the 1907 outbreak is discussed in the above-named publications.

HISTORY, 1908–1916

The aphids were present on oats and wheat in early spring of 1908, in Oklahoma and Kansas, but were held in check by the activity of their principal parasite (*Aphidius testaceipes*) and rains. They were found in well established colonies as late as June, in Oklahoma, southern and northern Kansas, Nebraska, Iowa, Minnesota, North and South Dakota, and in July in central Montana, where they were very abun-

[1] EDITOR'S NOTE: Owing to our limited financial resources, it was necessary to to ask Mr. Kelly to cut his paper in half. He has very kindly complied with our request.

dant on a salt grass. The country was generally infested in the fall of 1908, and they successfully lived through that winter in the grain fields in many sections, the worst infested wheat fields observed being those following oats in northern Texas and southern Oklahoma, where in early April of 1909 they had the appearance of a serious outbreak, but the favorable weather in late April and May gave the crop advantage and very little damage was done. A scattering few were observed in North Carolina and South Carolina.

In 1910 the species was very scarce west of the Mississippi river, but was observed in damaging numbers at several places in Illinois and Kentucky. In 1911 they were generally distributed through the eastern states. In eastern Oklahoma a limited incipient outbreak occurred; the heavy rains held it in check. They were reported from eastern and southern New Mexico. In 1912 few were observed anywhere, as was the case for 1913, except in South Carolina. In 1914 they appeared in large numbers in South Carolina, Georgia, and in scattering numbers over most of the eastern states, where they damaged oats and wheat. They were quite common from northern Texas to Nebraska. In 1915 they were common in South Carolina, Tennessee, Georgia, Texas, Oklahoma, Missouri, Arkansas, and Kansas. By November and December they had become so numerous in Kansas and Oklahoma in a few fields of wheat as to cause uneasiness among the farmers. In 1916 they occurred in damaging numbers in northern Oklahoma and southern Kansas and in a small area in northeastern New Mexico, also in scattering numbers to central Texas on the south and Nebraska on the north.

The Insect

Toxoptera graminum is an aphid of pea-green color, with a distinctly darker green stripe down its back, with black-tipped cornicles, and with a single forked cubital vein—these characters readily distinguish it from those most commonly found in wheat and oat fields, viz., *Macrosiphum granaria* and *Aphis avenæ*. It takes its nourishment by piercing the epidermis of the leaf with a beak adapted for drawing the juices therefrom; the effect upon the leaf is to cause it to take on a reddish-brown color, and, when heavily infested, to die.

In common with other aphids, its manner of reproduction is both sexual and asexual. In latitudes south of the 35th parallel, it appears that it only reproduces asexually, and north of this parallel both sexually and asexually. One thing very noticeable in the outbreak at Leavenworth was the entire absence of oviparous forms in the fall of 1907, and their presence in the fall of 1908.

The minor outbreak of 1909 in southern Oklahoma and northern Texas was not observed in the fall of 1908, nor was it followed in the

fall of 1909. However, during the fall and winter of 1909–1910 an experiment was conducted at Wellington, Kansas, laboratory, for the purpose of obtaining information on this point. In November a number of Toxoptera were placed on a breeding plat near the laboratory at Wellington for careful study of their resistance to freezes and to see what potent factors determined the sexual forms. On December 31 an examination was made, and it was observed that both adults and young were still alive on the wheat plants; though we had had several days of zero weather, no sexual forms occurred. January 27, 1910, many were still alive, and had survived some very severe weather, and there were still no sexual forms. On March 25, 1910, a few adults were found with no young accompanying them. These had evidently passed the winter, having found a protected place beneath some of the thicker growth of the plants. Special searches were made on this date, for oviparous forms and eggs, but none were found. On two occasions, one in December, 1909, and one in January, 1910, full-grown aphids and young which were frozen to bits of straw or ice, were brought into the laboratory, were allowed to gradually thaw out, and were later placed in breeding cages, where they grew, reproduced normally, acting as if they had not been in the cold weather at all; yet they produced no sexual forms.

In the fall of 1915 the insect was carefully studied in reference to sexual forms in the vicinity of Wellington, Kansas. Wherever the species was very abundant in wheat fields the plants, dry grass, and soil were examined carefully for eggs and a large number of the aphids were brought to the laboratory, where they were kept in breeding cages, both indoors and out, but at no time did the sexual forms appear. The question arises, then, what causes these forms to appear. Evidently it is not cold weather, because we had extremely cold weather during the winter of 1915–1916. We did not have such extreme cold weather during the fall of 1907 and winter of 1908. However, the notes indicate in the fall of 1908 that egg-laying forms were found on blue grass at Leavenworth and on wheat at Wellington.

Causes of Outbreaks

There have been four disastrous outbreaks of this insect, one in 1890, one in 1901, one in 1907, and the one in 1916. Aside from these, there have been a few minor outbreaks, but it appears from information gained from the weather records that the causes for the minor outbreaks in restricted localities have been similar to the causes of the larger outbreaks; at least, they are comparable to the seasons preceding the 1907 outbreak and the season preceding the 1916 outbreak, which were quite similar.

The season preceding the outbreak in 1890 was one which would have grown volunteer wheat and oats throughout the summer in the section of the country where the Toxoptera were abundant. Furthermore, it appears that the winter of 1889–1890 was of a mild type, especially in southern Ohio, southern Illinois, southern Missouri, and Texas. The spring of 1890 opened quite early and warm, but later changed to cold, raw weather, which continued up until the latter part of May. These conditions are readily comparable to the weather conditions of the spring of 1907 and the spring of 1916.

The outbreak of 1901 seemed to be confined mostly to northern Texas. By consulting the weather records, we find that in 1900, August, September, October, and November were very rainy months. This, of course, afforded an abundance of volunteer oats and wheat. March of 1901 opened up with showers and rains, which continued into April, with the weather turning cool with near frosts in April. The rains during the month of May were very light and a drouthy condition existed in north central Texas. It will be seen here that we have a condition very similar to that of 1889 and 1890.

Continuing our investigations, then, to 1906, we find that during the summer and fall the weather conditions were favorable for the growth of volunteer grain from central Texas to Nebraska, that is, rainfall was well distributed throughout July, August, and September. There are no records on file as to the amount of volunteer grain. However, our more recent investigations lead us to assume that there was plenty of volunteer grain where the rainfall was as abundant as in this season. The following winter was very mild. The spring of 1907 opened early and with slight rains in March and April, but here the weather man got his calendar mixed and we had it very cool in April and May, continuing cool up until late May. This insect, therefore, had the most favorable opportunities for increase.

In 1908, following the severe outbreak of 1907, a small area of wheat and oats in northern Kansas was damaged, this outbreak being evidently continued from the outbreak of the spring of 1907. Investigation indicated that the insect had been present in the infested fields since the spring of 1907, at which time the entire country to the south was being devastated, also that the devastated wheat fields had been planted to oats, and that occasional rains in July, August, and September had kept the oat plants suckering and green throughout the summer, and with the volunteer crop coming early in July, the aphids were permitted to feed and breed freely in the field, until wheat was sown. Shortly after the wheat was sown, the frosts killed down the oat plant, thus precipitating the Toxoptera on to the wheat; it, being young, of course succumbed readily. The devastation was not very

widespread, but indications in the fall of 1907 were that, in the spring of 1908, there might be a heavy infestation or general outbreak, should the spring be cold and backward as it was in 1907. The wheat fields were surrounded by blue grass in which Toxoptera were plentiful in November, 1907, and where they remained till the following spring. The fall was rather warm, the winter was not very severe, and it was not surprising to find as many as forty to fifty half-grown to adult aphids on a plant in early February and March, 1908.

The aphid showed up in abundance in the spring of 1909, in southwestern Oklahoma and northern Texas, where they did a lot of damage and threatened an outbreak, but here the parasites were present, and these, together with continued warm weather and considerable rain throughout April and May, held the pest in check.

Several wheat and oat fields in eastern Oklahoma were rather badly damaged in the spring of 1911 and in one or two fields, as much as twenty-five to fifty acres had been devastated. The oats were rather large at this time, and were heavily infested, many plants turning brown and dying. Owing to the downpour of rain on the night of April 8, the aphids seemed to be rather scarce, many of them being buried in the soil. A careful investigation all around this infested territory indicated that the insect must have been in that immediate locality since fall, 1910, as it would have been very difficult for them to have come from a distance, on account of the territory being more or less surrounded by timber, with wide sections of timbered land between this section and other cultivated sections. There was considerable blue grass growing near the fields, along the fence rows, which contained a number of aphids, and it is probable that the grass was more or less responsible for their passing the winter and getting an early start. May 5, these fields were practically free from the pest, and the plants were making a good growth. The heavy beating rains during April evidently cleaned the aphids off the plants. Inquiry among the farmers revealed the fact that there were considerable volunteer wheat and oats throughout the vicinity during the summer and fall of 1910. In one field where the volunteer oats were very plentiful all through the summer and fall, the Toxoptera gained such headway that they cleaned up the wheat, the field being seeded to oats early in the spring of 1911, and the oats being devastated. In this outbreak, then, there seems to be further indication that the volunteer oats and wheat were directly responsible for their presence in the fall, and continued presence in the spring. The rains in April and early May were responsible for their destruction, and from all indications the parasite *Aphidius testaceipes* was not a controlling feature, although present in large numbers.

During 1911, this species occurred everywhere in the midwest; however, the rains were general, and the species did not become abundant. The volunteer oats which were rather plentiful in August and early September died out later on account of the dry weather and cultivation, and by November it was very difficult to find Toxoptera at all.

The insect was not observed during 1912 in the vicinity of Wellington, nor practically any other place in the west. In May, 1913, a few were found on young wheat and quite a number on *Hordeum jubatum*. Wheat and oats were too far advanced, and with warm weather there was no danger from them. None could be found during the late summer and fall of this year.

1913 went on record as one of the hottest and driest years for the middle west, there being several weeks without rain. The rains came in plenty by mid-September, but none of this species were found on the wheat. Mr. W. E. Pennington made an excursion through northern Texas and southern Oklahoma, during the fall, and found a few individuals here and there on oats.

Early in April, 1914, reports of the insect came in from southern Oklahoma, investigation indicated that a few could be found on oats and wheat, and by mid-May they were generally distributed over Oklahoma and southern Kansas; however, the oats were large and wheat heading, so no damage was done. In December they were generally distributed over northern Texas, Oklahoma, and Kansas. The rains had been sufficient during August, September, and October, for growing of crops, but July was a record breaker for heat and drought.

In the spring of 1915 the aphids were plentiful throughout the west. This being an unusual year, with an abundance of moisture, especially in June, July, August, and September, the wheat and oat plants suckered freely, and were followed by an abundance of volunteer small grain, very early in the summer. The oats and wheat being fresh and juicy, naturally gave the insects food for rapid multiplication. In the fall it was not difficult to find good-sized colonies in every wheat field, and especially in fields following oats; by early December there were a number of wheat fields devastated in northern Oklahoma and southern Kansas. The frosts in October and November killed out the volunteer oats, thus precipitating the Toxoptera onto the small wheat, which they severely injured. The area of infestation seemed to be limited to about two counties, Grant county, Oklahoma, and Sumner county, Kansas. However, they were found almost everywhere in scattering numbers, throughout northern Texas, Oklahoma, Kansas, and even in northeastern New Mexico, where they were doing considerable damage to early fall-sown grain. Aphids were collected from points over the

west and kept in breeding cages for parasites, *Aphidius testaceipes*, which were reared from nearly every locality.

During the winter of 1915–1916 we had several freezes, the thermometer going as low as nine degrees below zero. Investigation during the winter indicated that the insect was living in the wheat stubble fields, along the protected fence rows, hedges, especially in rank wheat, and many of them crawled under clods. The weather warmed up rather early in March, 1916, with 80 to 90 degrees temperature during the last ten or fifteen days. The Toxoptera came from their hiding places and began to breed freely on the wheat. Our observations at that time showed that they were present in practically all of the thick growing wheat, the thin wheat not being infested. During March and April oats were planted in abundance, practically the largest acreage ever sown in southern Kansas and northern Oklahoma, because the wet fall of 1915 prevented seeding the land to wheat. By the middle of April, oats were sprouting and coming up from southern Oklahoma to central Kansas. The weather remained cool during this time, and Toxoptera continued to breed freely on the wheat. About the last week of April they began to migrate from the wheat to the oats, and by the first day of May it was not difficult to find the winged forms and small colonies on practically all of the oat plants throughout this territory.

Outbreak Imminent

The outbreak of 1916 began in the spring of 1915. As indicated by the above report, this insect is practically present at all times in some of our fields, more or less abundant, and ready to increase with the slightest favorable opportunity. In 1915 they were observed almost everywhere an entomologist who was interested in the species visited and looked for them. The cereal and forage crop entomologists of the Bureau of Entomology were observing them from South Carolina, across the continent through Tennessee, Missouri, and Texas, to New Mexico. The favorable conditions through June, July, August, September, and October of 1915, with its abundance of volunteer wheat and volunteer oats throughout all of the western states, extending from north central Texas to Nebraska, gave them the most excellent opportunities for establishing themselves. As fall approached, the farmers were asking if we were to have an outbreak of "green bug." Our one answer was, we cannot say, because we do not know what the spring will bring us, nor what the winter will do for the insect.

Investigation in December in northern Texas, by Mr. C. L. Scott, indicated they were rather plentiful northwest of Fort Worth, in the vicinity of Bowie and Ballinger, where there was an abundance of oats

and wheat, and they were also quite plentiful in the vicinity of Winters and Wichita Falls, and in the district around Sherman.

The species having been under close observation in the vicinity of Wellington throughout the season and since we had noticed their continual gradual increase up till October and November, 1915, we began to suspect that they were increasing more rapidly than usual. The first week of December they were so abundant as to be doing considerable damage to a number of wheat fields in Sumner county, Kansas, and in Grant county, Oklahoma, the heaviest infestation being in the vicinity of Medford. Upon noting the heavily infested fields near Medford, it was deemed advisable to make a thorough search of Grant county, Oklahoma, and Sumner county, Kansas, for the pest. Accordingly we drove some eight or nine hundred miles east, west, north, and south, in search of fields which might be as heavily infested as those around Medford and immediately west of Wellington, Kansas. No such infestation was located, but the insect was found in almost every wheat field visited, especially in wheat fields following oats. In almost every instance where we found as many as a dozen or more Toxoptera, we also found *Aphidius testaceipes*. The number of parasites present indicated that under favorable weather conditions in the spring we would not have an outbreak of this pest, if it was within the power of the parasite to control the pest, as had been claimed for it by one writer in discussing the outbreak of 1907, and the smaller outbreaks of 1908 at Leavenworth, Kansas, of 1909 in southwestern Oklahoma, and of 1911 in eastern Oklahoma. However, in the three latter cases, favorable rains assisted the parasites in the control of the pest, and I would not feel at liberty to give the parasites too much credit for what they did in controlling these three incipient outbreaks.

Outbreak Inevitable

On the 25th of April, after having investigated a number of fields in widely separated districts, it was apparent that we were to have an outbreak of this pest if the weather continued as it had been for the last thirty days. It seemed advisable that I inform the state officials that an outbreak was pending. I received a telegram from Mr. Dean, advising me that his able assistant, Mr. McColloch, would be in Wellington the morning of the 28th, and a long distance telephone message from Professor Hungerford, acting in charge in the absence of Dr. Hunter, stating that he would be in Wellington the morning of the 29th. Mr. McColloch arrived in Wellington at 7.15 a. m., April 28, and we started out on an automobile trip about 8 o'clock. We went west from Wellington on what is known as the Chisholm Trail, out by the way of Argonia to Harper, Kansas. We found Toxoptera quite abundant in

wheat fields on farms which I had visited several times recently. The wheat field on the Wilkerson farm, which was pastured in the fall, thus being freed of the pest, was also heavily infested at this date, and to the south an oat field was very heavily infested. We expressed an opinion that the Toxoptera were not abundant enough in the oats nor in the wheat to cause alarm. We visited the Treekman farm, where they were numerous in the fall, the wheat being practically devastated, except near the north edge, and Mr. McColloch found one parasite in a brown aphid. Living aphids collected from the Treekman field gave us a few parasites within the next ten days. Continuing the trip south from Harper, by way of Anthony, to Manchester, Oklahoma, we found Toxoptera much more abundant and began to change our opinion to one of some probability of serious damage, and accordingly Mr. McColloch wired the authorities at Manhattan that "the 'green bug' was generally distributed over all grain fields in Sumner and Harper counties, and if cool weather should prevail the next two weeks, the injury would be great, especially to oats, not only in southern Kansas, but probably over the greater part of the state." On the return trip from Manchester by the way of Bluff and eight miles south of Argonia, we found the "green bugs" much more numerous than we had along the Chisholm Trail. We did not find parasites elsewhere than on the Treekman farm, but the collections of Toxoptera from the vicinity of Manchester gave us parasites later.

On the morning of the 29th of April, Mr. Hungerford, together with Mr. Wellhouse, a student assistant of the University, arrived in Wellington. These men, together with Mr. McColloch and myself, drove east of Wellington toward Winfield, south to Arkansas City and on south to Kildare and Blackwell, Oklahoma, back by the way of Renfrow and South Haven. We found the species present in oat fields between Wellington and Oxford; in the oats and wheat to Winfield and to Arkansas City, but very scattering. One mile south of Arkansas City we found a forty-acre wheat field practically devastated, this being the heaviest infested field we had found in two days' drive. A careful search by these gentlemen and myself indicated that there were no parasites present. A number of aphids were collected and put in breeding cages, but no parasites issued. South of Arkansas City to Newkirk and Kildare we found a number of heavily infested oat and wheat fields. A number of the aphids were collected, but from these no parasites were reared. In the vicinity of Blackwell, Toxoptera were rather abundant. East of town there seemed to be no injury. They seemed to become more numerous as we went toward Blackwell from Kildare. Going west from Blackwell, we came to some of the fields which were heavily infested in the fall of 1915. These fields were being

damaged beyond doubt, many leaves being brown and heavily infested. The oats were two-leaved and 100 per cent infested. In the wheat fields where we found parasites plentiful in the fall, today we found some half dozen brown parasitized aphids. The individuals parasitized had crawled up to the tip of the topmost leaf of the plant, where they had changed to the brown form. This seems to be a characteristic of the parasitized aphid, and owing to the scarcity of them, it assisted us greatly in finding them. A large number of the living aphids were collected from wheat plants, and placed in a breeding cage; no parasites were reared from these, which indicates that the adult parasites had not been active in this field for some time in the past, probably not since last fall. About seven miles south of Hunnewell, Kansas, the fields were heavily infested, and here we found a few more of the parasitized aphids on the top leaves. Again we collected a large number of aphids and put them in breeding cages, from which no parasites were obtained.

Coöperation with State Officials

The apparent absence of the parasite from practically all of the fields in southern Kansas in April afforded an excellent opportunity for the study of parasite introduction. Representatives of the Kansas institutions came to Wellington on April 28, for the purpose of investigating the fields and to determine whether the parasites were present, and if they were absent, whether we could find a field to the southward where they were present in sufficient numbers that we could collect large numbers and later introduce them into the fields. Upon the arrival of the officials, we held a conference, wherein we decided that we would go together in the automobile of the department to the various fields in the vicinity of Wellington, and make a close search for the parasite.

Introduction of Parasites

On the 30th of April a slight misty rain fell all day. It was very cool and disagreeable, the wind being from the north. This was followed on May 1 by another cool day, with the wind in the northeast, threatening rain all day. However, in company with Messrs. Hungerford, Wellhouse, and Lawson, of the University of Kansas, T. H. Parks of Manhattan, who replaced McColloch, and E. L. Barrett, my associate, we began investigation of the fields in the vicinity of Wellington, for the purpose of determining whether the parasite, *Aphidius testaceipes*, was present. The oat and wheat fields on this day were generally and evenly infested, no spot more infested than another. Large numbers of the winged forms had flown into the fields and had started small colonies. Some of the offspring of the winged forms had reached maturity

and had begun to reproduce. We carefully looked for the parasites in the oat fields, and in the wheat fields to the north of town, spending the entire day making this search. We were unable to find parasites on the Toxoptera. We did find parasites on two other species of aphids, which were on weeds and grasses in the vicinity of the wheat fields. These parasites were subsequently reared and an attempt was made to introduce them into Toxoptera, but the attempt was futile.

Several oat and wheat fields were thoroughly investigated and determined not to contain the parasites (*Aphidius testaceipes*). We extended our investigation further to include the vicinity of Anson, where one individual parasite was found on the 25th day of April, by E. L. Barrett. Here we found four or five parasites in brown aphids. Then we went to the fields on the Treekman farm, where we found a few scattering individual brown aphids and the aphids literally destroying the wheat. On the Rarick farm, northwest of Mayfield, we found several parasites. However, since the parasites were not present in the fields northeast of Wellington, and especially those which we examined carefully, we decided that we would go to Medford, Oklahoma, where the parasites were abundant, secure a lot of them, bring them to these fields, and attempt an introduction. Accordingly, on the morning of May 4, we proceeded to Medford by automobile, for the purpose of securing the parasites. Driving on to South Haven and across to Caldwell, both wheat and oat fields were heavily infested and in danger of being destroyed. Just south of Caldwell we found wheat fields very heavily infested and beginning to show signs of dying. The change for the worse since the 27th of April was very evident. A careful search in these fields indicated that the parasites had not yet reached them. In some of the wheat fields the plants were eight to ten inches tall, but were dying, and dying fast. A large number of the aphids were collected in this vicinity and taken to Wellington, where no parasites were reared from them. We continued our investigations south and west of Caldwell to Renfrow, the fields being more and more seriously infested, and more seriously damaged, the farther we went. The oats were beginning to take on a red or brown appearance. Oats which were sown in a devastated wheat field just north of Renfrow were practically dead. A few parasites were found on oats and wheat in this field, more than we had found at any place south of the Treekman farm, and more than we had found anywhere, other than in the wheat field northwest of Medford. The situation in the vicinity of Medford was alarming; the oat fields were turning brown, as if a fire had swept over them. The wheat fields were just as badly infested as the oats, but the wheat, being larger, infestation did not show to be quite so severe. Many farmers were

harrowing or dragging the fields with brush drags in an effort to dislodge the bugs. Their efforts were in vain. In the field where the parasites were so abundant on previous visits, they were very abundant now, with an opportunity for our securing a lot of them. We collected several thousand of the brown aphids and several more thousand of the parasitized aphids which had not yet shown their parasitism. Many adult parasites were abroad, ovipositing. After making the collections of parasites, we drove south to Jefferson, where we found conditions quite the same as north of Medford. We returned to Wellington on a road leading directly north to Argonia. On this road we found some very heavily infested wheat fields which were practically devastated, and all of the oat fields south of the Kansas line heavily infested and in danger of being devastated; the parasites were in almost all of these wheat fields, and in some of the oat fields, but at no place were there so many as in the field one-half mile northwest of Medford.

On the morning of the 5th of May we proceeded to distribute about thirty thousand parasites and seventy-five to one hundred thousand aphids which had not yet shown parasitism, in each of three fields, two oat and one wheat field, which had been previously selected because of the absence of the parasites. We placed the parasitized Toxoptera in three points in each field, forming a triangle, the points being about one hundred yards apart. The living aphids, of course, began at once to crawl upon the plants for feeding purposes. The brown parasitized ones remained on the cut plants which we brought to the field. The increase in the aphids in the oat fields since our first visit on the 29th of April had been immense, far more than anyone could expect, fully 100 per cent of the plants being infested and some of them having from seventy-five to one hundred aphids to the plant. On April 29, we doubted there being a sufficient number of aphids on the oats to warrant an attempt at introduction of parasites. Representatives of the two Kansas institutions and myself were careful to make another examination of the plants for parasitized aphids immediately preceding the introduction, and we all expressed the opinion that there were no parasites present. Examination of the fields on the 6th of May indicated that the living introduced Toxoptera had crawled upon the plants and many of them were turning brown; some of the plants contained as many as six or eight of the brown aphids. We continued our investigation in other portions of the field, where the parasites were not introduced, but could not find a change in the situation, except the rapid increase of aphids and reddening of the plants. On May 8 the conditions in the three fields were very similar. Large numbers of the introduced aphids had crawled upon the plants and had turned brown;

on this date as many as thirty brown aphids could be found on a leaf, but brown aphids could be found only in the immediate vicinity of the small area where we had placed them. Again we searched thoroughly for parasitized aphids in other parts of the fields, and none were found. The Toxoptera were increasing in vast numbers and large numbers of winged forms were coming into the field. The plants were three and four leaved, as against one and two leaved on the 29th of April, with every leaf heavily infested and reddening. This being a warm day, the adult parasites were issuing from the brown aphids brought up from Medford, but not from those on the plants. Whether we had introduced enough parasites in any of these fields to overcome the heavy infestation seemed to be doubtful; they seemed to be gaining no headway, while the Toxoptera were gaining by great strides. Many of the oat fields were from 85 per cent to 100 per cent infested, the plants turning reddish-brown everywhere. Mr. Parks could not remain with me for the next day, so a drive of about one hundred miles to the north was made alone. I observed the Toxoptera to be very abundant in all the oat and wheat fields, to a line just south of Wichita, this line being the southern border of a rain which occurred on the 30th of April. North of Wichita to Newton very few Toxoptera could be found. Returning west of Wichita through Goddard I found the same conditions. Immediately south of the Santa Fé Railroad I began to find oat fields which were heavily infested.

On the 9th of May, it was decided that we had not made sufficient introduction of the parasites to be fully satisfactory, and upon the request of Dr. Hunter and Mr. Hungerford, we decided that we would return to Medford, secure more parasites, and try for further introduction. The fields were now becoming very heavily infested everywhere from Wichita south to El Reno, Oklahoma. Our observations en route from Wellington to Medford indicated that all of the wheat fields and all of the oat fields were heavily infested; oats having the appearance of having been swept by fire, much of it being totally destroyed, and wheat suffering severely. The conditions were more and more appalling as we neared Medford. We secured several soap boxes full of infested plants containing several hundred thousand of the parasites, from the field one-half mile northwest of Medford. These were brought to Wellington and released in the fields, where we had not put parasites on former dates. However, preceding the introduction, Messrs. Wellhouse, Lawson, Barrett, Scott, and I investigated the fields; we found a few parasites. About two hundred thousand parasites were liberated in each of two oat fields immediately west of town. The adult parasites were numerous in the boxes, issuing en route; these began ovipositing immediately upon being released.

On the 11th of May adult parasites continued to issue, from the introduced lots, but the cool weather retarded their activity and they had not distributed themselves very far from the points where we made the introductions. At a point one hundred and fifty yards east of the point of introduction in one of the fields, where introduction was first made, a number of parasitized aphids were found, and among them several winged forms, which indicated that some of these parasites had come in from abroad, and were not of those introduced. Again at five hundred yards east of the point where the introduction was made, bordering on the east side of the field, several parasitized Toxoptera were found, among them several winged forms; it is even more probable that these came in from abroad. The winged forms had been very numerous during the last few days, flying toward the north, and it would appear that these winged forms which had blown in from the south had lighted in these fields and had changed to the brown form, containing the parasite, and were not from the sources of introduction. This was further proven by the fact that the parasites which oviposited into the aphids on the morning of the 5th had not yet caused the aphids to turn brown, and further, by the fact that winged forms collected while in flight were changing to the brown form in the laboratory.

On the 18th of May there were not as many brown aphids to be found in the fields of first introduction as there were on the 11th of May, and in the fields where the second and larger introductions were made only a few adult parasites could be found, and it was difficult to find parasitized aphids away from the points of introduction. The cool weather between the 11th and the 18th had prevented them from multiplying or parasitizing any more aphids. The situation was growing worse daily with the weather continuing cool and dry. So far as could be determined, therefore, the introduction of the parasites was not a success, owing to the fact that practically as many parasites came into the field unaided by us as we introduced. The Toxoptera were devastating the oats and damaging the wheat very badly in spite of the parasites we had introduced.

An Important Excursion

Prof. G. A. Dean was regularly advised of the situation in southern Kansas by his assistants, J. W. McColloch and T. H. Parks. A telegram from Professor Dean stated that he, together with Professors Jardine and Call, would come to Wellington Monday morning, May 15, if the weather was suitable for auto travel. When they reached Wellington they informed me that it had been raining at Manhattan for several days, and that they had come through a heavy rainstorm all the way from Manhattan to about five miles south of Wichita. This

rain had been very heavy from Wichita north, extending northwest through the southern edge of Reno and on out to Stafford county, northward.

The weather being fine, these gentlemen accompanied me in my automobile on an inspection trip south of Wellington through Hunnewell, Kansas, to Nardin, Oklahoma, thence west to Medford, and directly north to Mayfield. We found the wheat fields heavily infested from Wellington to Medford, many of them being devastated, some of them being plowed up. The oat fields observed on this trip were condemned as worthless by all of these gentlemen. Many of the oat fields were being plowed up, and listed to sorghums, and many of them were so heavily infested as to be absolutely worthless. On this day we found a few of the adult parasites, or parasitized Toxoptera, in practically every wheat field we visited, and a few in oat fields. We continued our drive to the north on the morning of the 16th, going through Peck to Wichita, Newton, Mount Ridge, to McPherson, and on to Salina. We found the devastation extended to the southern border of the rain which occurred on the 13th of May, just south of Wichita. The heavy rain had beaten the aphids off the plants and caused the oats and wheat to outgrow the attack. A few individuals were found all the way from Newton north to Salina, but at no place were they in such numbers as to cause alarm. On the return from Salina I was alone, but went out by the way of Hutchinson. Southeast of this town many fields were heavily infested, but no devastation was yet apparent. Southwest of Wichita the situation was about the same, until I passed out of the rain belt.

Flight of Migrants

A few winged Toxoptera were caught on a large wire screen March 28; however, the general flight did not begin till the last of April or the first of May.

By the 18th to the 20th of May the oats and wheat were dying everywhere in southern Kansas and northern Oklahoma. Millions of the winged forms were flying and lighting on everything green, especially young corn. In northern Oklahoma many hundreds of acres of corn were devastated, and sorghums damaged by the winged forms. The first generation was about all that was produced on the corn and sorghum, the second generation seeming to be unable to survive. On May 22, billions of the bugs were flying all day long, and late in the afternoon it seemed that the air was absolutely full of them. They obstructed travel by getting in every one's eyes. Street lights were dimmed by them. The general direction of flight was always in the

direction the wind was blowing; a slight change of direction of wind changed their course as readily. Many of the winged forms carried larvæ of *Aphidius testaceipes*.

Disappearance after Devastation

The oats being dead and wheat heading, with the leaves drying up, there was very little left for the bugs to live upon; thus they destroyed themselves. During the last days of May and early June the weather warmed up and also continued dry. The bugs, having killed down their preferred food plant, were necessarily precipitated upon the soil. What would become of the hordes of wingless forms was a question of considerable importance. The winged forms had flown away to other fields, especially to the corn and kafir adjacent. Whether the hordes of wingless forms could reach the corn and kafir depended on their durability for long hikes; but fortunately they were too frail and readily succumbed on the heated surface of the soil.

The End of the Outbreak

During the last week of June and first two weeks of July, we made some long auto drives in southern Kansas and Oklahoma, observing the disappearance of the pest. A very few small fields of oats had been harvested, many had been planted to kafir and fetereta. The oat plants being dead, the bugs had necessarily died or left the field; wherever a green plant could be found, also a few aphids could be found. Wheat which had not been devastated was ripening; the bugs had about disappeared from them. By the middle of July it was difficult to find one anywhere, and those so fortunate as to find a green oat or wheat plant were being parasitized by *Aphelinus semiflavus* and not by *Aphidius testaceipes*. Together with *Toxoptera* went *Aphidius testaceipes* and the Coccinellids. The "green bugs" practically disappeared from this locality during the summer, and by late fall none had been found in Sumner county, though we had authentic reports of their appearance in McPherson and Cowley counties, Kansas. Thus the end of the most disastrous outbreak of "green bugs."

In Kansas the devastation reached an enormous acreage, about 250,000 acres of oats and 100,000 acres of wheat being devastated, this loss falling principally on four counties. The loss in Oklahoma was even greater than in Kansas, being as complete in destruction and covering a much larger area. The acreage of oats devastated has been estimated at 350,000, the wheat 160,000 acres, with 75,000 acres of wheat badly damaged, making a total of 600,000 acres of oats, 260,000 acres of wheat totally destroyed, and 75,000 acres of wheat badly damaged.

A COUNTY-WIDE SURVEY TO DETERMINE THE EFFECT OF TIME OF SEEDING AND PRESENCE OF VOLUNTEER WHEAT UPON THE EXTENT OF DAMAGE BY THE HESSIAN FLY

By T. H. PARKS, *Extension Entomologist, Kansas State Agricultural College*

During the season of 1916 the Hessian fly (*Mayetiola destructor*) took a heavy toll from the wheat fields of central Kansas and pushed farther west into the state than had previously been recorded. The injury in the northern part of the state extended westward almost to the 100th meridian. The greatest injury occurred in the central part of the state, where this survey was conducted, and covered five counties in the heart of the hard wheat belt. The Hessian Fly Train,[1] operated in 1915 by the Atchison, Topeka and Santa Fé Railway Company in coöperation with the Kansas State Agricultural College, had made numerous stops in this section. The lectures given on this train, together with newspaper articles published at that time, served to set before the farmers a general understanding of the importance of applying the best known control measures in preparing the seed-bed and sowing the 1916 wheat crop.

The entomologists of the Kansas Experiment Station have always emphasized four things: (1) Thorough preparation of the seed-bed; (2) Destruction of volunteer wheat; (3) Sowing after the fly-free date, and (4) Coöperation among growers.

In the past, the farmers of Kansas have probably observed number three first, forgetting that along with this should go number one to insure a good vigorous plant in order to offset the disadvantage of a short growing season in the fall. Frequently this wheat fell before the attack of the spring brood of Hessian flies. Other growers who have paid more attention to securing a good seed-bed along with sowing late, have suffered loss because of the presence of volunteer wheat in the seed-bed. Coöperation comes last of all and is usually delayed because of lack of confidence, due to the failure to control the fly in individual cases by applying only one or more of the other three recommendations. Moreover, coöperation in all of these practices is often made difficult, due to the fact that Kansas farmers operate large acreages. To finish in the proper time seeding is frequently commenced early, and the earliest sown wheat becomes infested by the fall brood of flies.

McPherson county, central Kansas, was chosen as a county in which to conduct an extensive Hessian fly survey. This was in the nature of

[1]Dean, Geo. A., JOUR. ECON. ENT., vol. 9, No. 1, 1916.

"follow up" work to learn the results of individual attempts to control the insect.

In 1916 there was early observed in this county a great difference in the degree of injury caused by the spring brood of the Hessian fly. The grain in some fields suffered but little while in other fields it was ruined by the fly. Frequently the most seriously injured grain had been sown after the fly-free date. This fact the farmers were always sure to remember and especially if, as occasionally happened, a neighboring field which was sowed before the fly-free date had escaped with less injury.

To explain these differences, as well as to secure some definite data on the value of an unorganized effort to control the Hessian fly, a questionnaire was prepared, and 306 fields in this county were visited and the owners consulted. Among the questions asked these growers were the following:

1. When was the field sowed?
2. Was volunteer wheat present in the seed-bed at seeding time? None, medium or much?
3. Did early sown wheat join?
4. What crops occupied the field in 1914 and 1915?
5. Was any stubble burned in 1915?

It was desired to determine the answers to the following questions pertaining to the control of the Hessian fly over an entire county:

1. What per cent of McPherson county wheat-growers believed in and had waited until the fly-free date for their county to sow wheat in 1915?
2. How much protection was afforded the 1916 crop by sowing after the fly-free date *without regard* to the amount of volunteer wheat present in the seed-bed?
3. What effect did the presence of *different amounts* of volunteer wheat at seeding time, in fields sown after the fly-free date, have upon the injury done by the spring brood of 1916?

These fields were visited usually in company with the farmer and the wheat carefully examined for injury by Hessian fly. Account was taken of the presence of lodged straws, dead tillers and number of flax seeds found present in representative samples taken in different parts of the field. The infestation was then classified as slight, medium or heavy, as the case might be, and so tabulated together with the other records given by the farmer. No data on the 1916 yields were obtained as this survey was conducted during July, and factors other than Hessian fly contributed to make the yields variable.

This work was made possible in the limited time available through the assistance of R. R. Reppert of the Department of Entomology,

Kansas State Experiment Station, to whom acknowledgments are here due.

The accompanying data, including the tables and graphic comparisons, were prepared to show the effect of time of sowing and the presence of volunteer wheat upon the degree of injury by the Hessian fly in this county in 1916.

A comparison of Tables I and II shows the effect of the time of sowing upon the control secured. The good of late sowing is here more clearly observed than the evil of early sowing. It is left for the reader to explain why 23 per cent of the fields sowed before the fly-free date escaped with slight injury, though these fields must have been heavily infested in the fall and probably were the source of a large part of the spring brood which damaged the wheat throughout the whole county. Table II shows the value of late sowing when the seed-bed is free from volunteer wheat. The five fields that were seriously injured were all near and usually adjoining early sowed fields. In one case a four-acre strip was sowed early and on both the north and south of this the adjoining fields of wheat, which were classed in Table II, were found to be very severely injured by fly. The north field was the more severely injured of the two, presumably because of the prevailing winds from the south during the spring. The early sown strip was too severely injured to harvest. The protection afforded the wheat in Table II shows the importance of even an unorganized attempt to control the Hessian fly by sowing after the fly-free date. In this class it was observed that the extent of the damage usually depended upon the ability of the plants to overcome the attack of the fly larvæ. Usually but a few were observed on each plant, and in good soil and on seed-bed well prepared, these straws were able to mature a head and remain standing even though one flaxseed was present near the base.

The effect of the presence of volunteer wheat in the seed-bed was even more noticeable than was expected. The grower's word was accepted for the amount of volunteer wheat present in his seed-bed. This could usually be verified by inspection. It was thought best to make but three divisions in regard to the amount of volunteer wheat present. A comparison of Tables II, III and IV shows the effect of varying amounts of volunteer wheat upon the subsequent injury by the spring brood of flies to the main crop of wheat sowed after the fly-free date. The heavily infested fields in Table IV were often in worse condition than those in Table I where no attention was given to time of sowing. Wheat shown in Table IV was probably subjected to equally as severe an attack by the spring brood of flies as that in Table I, but had the disadvantage of being younger and with fewer tillers. The figures in the last three tables show clearly that the degree of in-

jury by the spring brood depends directly upon the amount of volunteer wheat present at seeding time. Hence, the importance of destroying this.

HESSIAN FLY CONTROL

Number of fields examined	306
Number in wheat 1915 and 1916	273
Number in wheat 1916, other crop 1915	33
Number sowed before the fly-free date in 1915	64
Per cent sowed before the fly-free date in 1915	20.9%
Number sowed after the fly-free date in 1915	242
Per cent sowed after the fly-free date in 1915	79.1%

TABLE I

Sowed before the fly-free date with or without volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	15	23.4
Medium	12	18.8
Heavy	37	57.8

TABLE II

Sowed after the fly-free date with no volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	78	73.6
Medium	23	21.7
Heavy	5	4.7

TABLE III

Sowed after the fly-free date with a medium amount of volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	46	44.2
Medium	40	38.5
Heavy	18	17.3

TABLE IV

Sowed after the fly-free date with much volunteer wheat in the seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	1	3.1
Medium	8	25.0
Heavy	23	71.9

No protection to the crop was noticed where the stubble had been burned over in 1915 and observations made in this county in 1916 give little encouragement from this source. The flaxseeds were too low on the stubble to be destroyed in large numbers. Less than 1 per cent of the acreage under survey had been burned in 1915 previous to plowing.

It seems that in Kansas, destroying volunteer wheat should take first rank in the war against the Hessian fly. After this is done there is little doubt of the good to be secured by late sowing. Either one done alone accomplishes little.

It was for the purpose of demonstrating these facts to the farmers of Central Kansas that this survey was conducted. Immediately after harvest in 1916 assembly meetings were held throughout McPherson county to give this information to the growers. Every effort was made to have county coöperation in Hessian fly control, and organizations by school districts were made to unite the farmers in an effort to control the Hessian fly in 1917. V. M. Emmert, County Agricultural Agent, coöperated in this organization work, and soon after harvest twenty-one assembly meetings were held throughout this county. Many of the men who attended these meetings had been visited by us during the survey, and had come to hear the results secured. These were presented to them as here given, and as these men had contributed toward the solution of this problem, a keen interest was felt by them. At many of these meetings definite organizations were made and as a result every effort was made to destroy the volunteer wheat in the seed-bed before sowing in 1916. In some localities less than 5 per cent of the 1917 crop was sowed before the fly-free date. At this writing some of the wheat sowed in the middle of September has been plowed under because of damage by the fall brood. To Extension workers these examples are an aid rather than a hinderance to the cause, for they stand as object lessons to the community. It is hoped that no organization will become so perfect that these self-invited demonstrations will be lacking.

STUDIES ON THE LIFE-HISTORY OF LIGYRUS GIBBOSUS DeG. (COLEOPTERA)[1]

By WM. P. HAYES, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

INTRODUCTION

Ligyrus gibbosus DeG. first came into prominence as an enemy of the wild sunflower. With our increasing knowledge of its habits, damage to new and important food plants is continually being charged to this

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 25. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Experiment Station.

beetle. The study of this species was taken up as a result of its growing importance as a pest of staple crops, and is being carried on as a part of the project on "Insects Injurious to the Roots of Staple Crop Plants" of the Kansas State Agricultural Experiment Station.[1]

Ligyrus gibbosus belongs to the coleopterous family Scarabæidæ, subfamily Dynastini. Fortunately, the references to this species have not been interspersed with synonymical confusion. Two described species, *L. morio* Lec. and *L. juvencus* Oliv., have been united with *gibbosus* by Horn (1875, p. 143).

The common names "carrot beetle," "muck beetle," "sunflower beetle," and "Ligyrus stalk beetle" have been proposed, none of which, because of their limitations, seem appropriate.[1]

History and Economic Importance

First mention of damage due to this insect is made by Comstock (1880, p. 274), who records adults as preying upon dahlias and the roots of sunflowers, both wild and cultivated. Webster (1889, pp. 382–383) records the beetle injuring carrots in Indiana, and Bruner (1891, p. 17) found them destructive to sugar beets in Nebraska. Weed (1895, pp. 156–157) reported the adults burrowing into and destroying stalks of corn in Mississippi, the damage being confined to limited areas, principally on corn land that had recently been in pasture. Howard (1898, p. 93) writes of injury to corn in Louisiana and carrots and dahlias in Wisconsin. The beetles are reported by Forbes and Hart (1900, p. 513) as abundant in Illinois and a brief account of the species is given. Chittenden (1902, pp. 32–37) describes the egg and adult and gives some notes from the United States Entomological Bureau on this species which he calls the "carrot beetle." The length of the egg stage was found to be ten days. Carrots are mentioned as the favorite food, while cotton and sweet and Irish potatoes are added to the list of host plants. Control methods are also suggested. This paper, although meager, is, by far, the best discussion of the species. Washburn (1902, pp. 47–49) reports damage to sweet corn and cites a futile attempt to use trap-lanterns in infested fields as a means of control. Essig (1915, pp. 245–246) states that adults have been reported feeding on the foliage of oak and elm and thinks that the grubs may be responsible for much damage to crops in California. A recent paper by Davis (1916, p. 264) states that "*Ligyrus gibbosus* and *L. relictus* have a one-year life cycle, the beetles pupating and appearing above ground in fall and reëntering the ground to pass the winter, not laying eggs

[1] The writer wishes to acknowledge his indebtedness to Prof. Geo. A. Dean, Dr. P. S. Welch, and Mr. J. W. McColloch for kindly advice and assistance in preparing this paper.

till the following spring. The beetles are present at lights almost the season through, due to successive overlapping of broods. The grubs feed on manure and other decaying matter but the beetle of *L. gibbosus* feeds on the roots of various weeds such as *Amaranthus* and *Helianthus* and not infrequently noticeably damages crops of sunflowers. An interesting habit of the *Ligyrus* beetles is that they copulate under ground."

The foregoing references practically represent the present status of our knowledge of this species.

Related Species and Their Importance

By far the most important species of this genus is *L. rugiceps* Lec., known in the Southern States as the "sugar-cane beetle." Titus (1905, p. 7) states that in 1880 many farmers in the South were forced to give up the growing of cane because of this pest. Corn is also liable to injury. Another species, *L. tumulosus* Burm., has frequently been mentioned (Ballou, 1915, pp. 121–147, *et al.*) as a pest of maize and cane in the West Indies. *L. relictus* Say has been reported in the larval stage as injuring the roots of pyrethrum (Smith, 1902, p. 490). Two other North American species, *L. laevicollis* Bates and *L. ruginasus* Lec., have, so far as the writer is able to learn, not been cited as of economic importance.

Distribution

L. gibbosus, which is widely distributed over the United States, has been found from the Atlantic to the Pacific ocean. This wide range can be, in part, accounted for by the strong flight of the adults. In the collection of the Kansas State Agricultural College, this species is represented from the following Kansas localities: Manhattan, Winfield, Junction City, Onaga, Newton, Leavenworth, Scott City, Hays, Dodge City, Grainfield, and Eldorado. Mr. Warren Knaus, of McPherson, Kansas, has kindly furnished additional Kansas records from specimens in his collection, taken in the following counties: Seward, Meade, Wilson, Saline, Rooks, Lincoln, McPherson, Reno, Kiowa, Gray, Finney, Ford, Scott, Lane, and Wallace.

Food Plants

The following is a list of the known food plants of the adult of *L. gibbosus:* potatoes, sunflowers (wild and cultivated), dahlias, sugar-beets, ambrosia, oak, carrot, corn, cotton, parsnip, celery, and elm. The food plants of the larva are: pigweed, sunflower, wheat, corn, and oats.

In the records of the Department of Entomology, Kansas State Agricultural College, was found a note dated August 19, 1902, recording the adults feeding on the roots of celery. A large celery patch, under irrigation at Scott City, Kansas, was almost ruined by this species. As many as twenty-five specimens were taken around a single plant. According to another record, four individuals were found in celery stubs at Portalis, New Mexico, August 18, 1909. At Gove, Kansas, September 22, 1908, this species did much damage to sugar beets. It has also been found feeding at the roots of sunflowers at Manhattan, Kansas.

Description of Life-History Stages

The Egg.—The egg (Pl. 12, fig. 2) superficially resembles those of other related genera, such as *Cyclocephala*, *Phyllophaga*, *Anomala*, and *Euphoria*. It is almost globular in form, one axis being slightly longer. When freshly laid, it is about 1.5–1.8 mm. long and as development proceeds an enlargement occurs so that, when ready to hatch, it has increased to about 2.5 mm. It is pure white in color, smooth, and shining. As the embryo develops within, the color changes to a duller white and some of the lustre is lost. A few days after deposition, the young larva can be discerned through the shell. Just previous to hatching, larval segmentation, movement of the appendages, and the opening and closing of the brownish mandibles can be observed.

Eggs are laid at the bases of plants, preferably in soil, containing a large amount of decaying organic matter. In laboratory cages, they were laid in loose soil to the depth of 5–6 inches. Oviposition occurs as early as May 29 at Manhattan. In outdoor cages, the first eggs hatched on June 19. In hatching, the larva, doubled over within the egg, splits the shell in the region back of the head. By merely straightening out the body, the anterior half of the larva becomes free, while the shell remains attached to the dorsal surface of the abdomen. The larva, by bending the body and pushing with its head, finally works itself entirely free. These efforts are aided by twisting movements and rubbing against the surrounding soil.

The average duration of the egg stage of 555 eggs was 10.9 days, with a maximum of 22 days and a minimum of 7 days. Egg-laying began May 29 and lasted until July 24. Eggs were not laid by females taken at lights after the latter date.

The Larva.—The entire body of the newly hatched larva is white, except the brownish mandibles. A few hours after hatching, the head begins to darken and takes on its characteristic brown color. The body assumes a characteristic bluish color, and after feeding for some time a black meconium, due to dirt in the alimentary tract, appears in the posterior end of the abdomen.

The full-grown larva (Pl. 12, fig. 3) is about 31 mm. long and 9 mm. in maximum width. The head is brown in color and rather roughly reticulated. The whole body color is of a bluish tinge as are the grubs in the genus *Cyclocephala*. The spiracles are brown and somewhat prominent. The last abdominal segment bears ventrad a patch of short, straight hairs arranged triangularly. The double row of spines, found in this region in *Phyllophaga* and other genera, is absent. Dorsad, the last segment is devoid of hairs, but a few are present along the sides. The anal slit is transverse. Spines are present on the upper surface of the thorax and abdomen, but they do not seem to be as conspicuous as in *Phyllophaga*. As is the case with other grubs, three pairs of legs are found. The larva may crawl either on its side or on its feet and, when disturbed, lies coiled on its side.

In Kansas, the grubs have been found feeding on the roots of corn, oats, and wheat. They also thrive in soil that is rich in decaying organic matter, such as pasture land and freshly manured fields. In rearing cages, during the early part of the larval stage the grubs were successfully reared in soil mixed with manure. When about half grown, the larvæ were transferred to soil containing germinating wheat where they thrived on the roots, and frequently whole kernels of wheat were eaten before the seed had an opportunity to sprout.

In soil cages, freshly hatched larvæ were frequently seen eating each other. This habit probably accounts for a considerable amount of the exceedingly high mortality in rearing cages. During the past summer, out of 555 larvæ hatched from eggs, only 38 were successfully reared through to the pupal stage. The greatest death-rate occurred in pot cages containing fairly large numbers of grubs. The mortality is also high in cages where the larvæ are kept isolated.

THE PREPUPAL STAGE.—The grub, when full grown, sheds the meconial mass in the digestive tract and assumes a quiescent or prepupal stage. The body becomes smaller, being about 25 mm. long and 7 mm. wide across the thorax. The bluish tinge is lost and the grub becomes white in appearance except for the last three or four abdominal segments which remain darker and are much wrinkled, giving this end of the body a glistening appearance.

Previous to the transformation to the prepupal condition, the larva enlarges its burrow in the soil by packing the surrounding earth. Here it changes to the prepupa and later to the pupa. The coiled prepupa lies on its side and wriggles actively when disturbed.

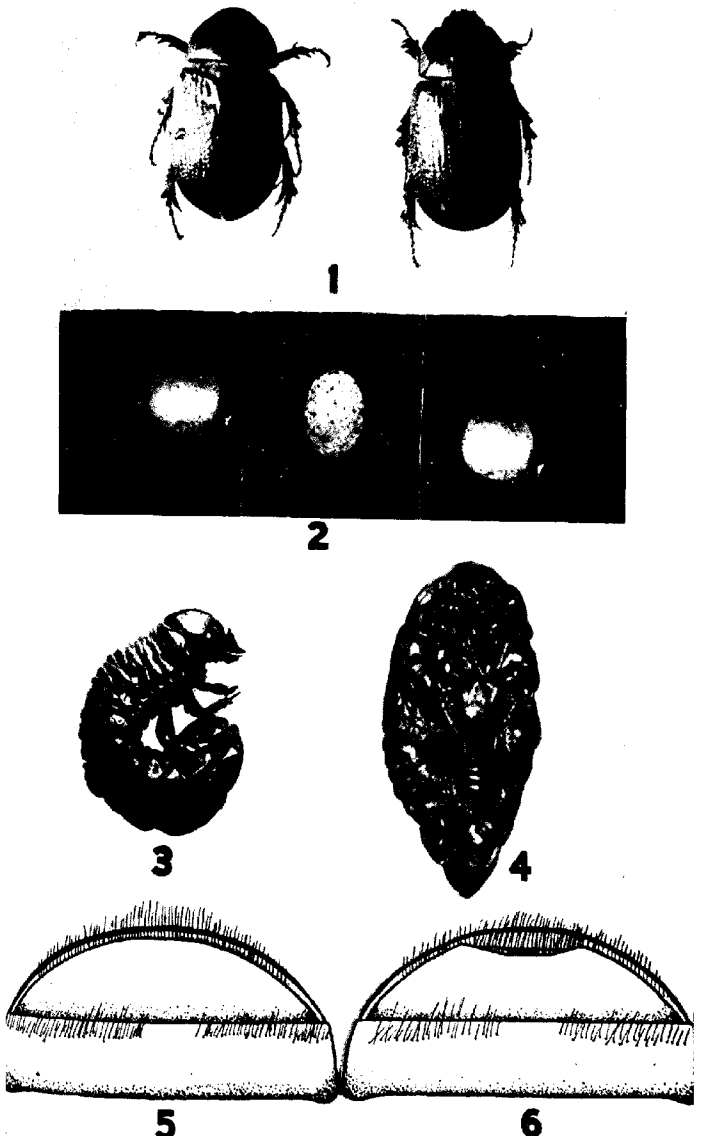
The combined length of the larval and prepupal stages was found to average 59.2 days for 36 specimens with a maximum of 80 days and a minimum of 43 days. The following table shows the exact length of each stage:

DEVELOPMENT OF GRUBS FROM HATCHING TO PUPATION

Record No.	Hatched	Became Prepupa	Length of Larval Stage (days)	Pupated	Length of Prepupal Stage (days)	Complete Time of Development (days)
565	June 23	Aug. 31	69	Sept. 6	6	75
390	June 26	Sept. 1	67	Sept. 7	6	73
472	June 28	Aug. 21	54	Aug. 25	4	58
533	June 28	Aug. 29	62	Sept. 4	6	68
896	July 1	Aug. 21	51	Aug. 25	4	55
1002	July 6	Aug. 23	48	Aug. 29	6	54
1083	July 6	Aug. 31	56	Sept. 6	6	62
1620	July 8	Aug. 31	54	Sept. 6	6	60
1637	July 8	Aug. 21	44	Aug. 27	6	50
1624	July 9	Aug. 23	45	Aug. 29	6	51
1640	July 9	Aug. 28	50	Sept. 3	6	56
1623	July 9	Sept. 5	58	Sept. 12	7	65
1962	July 12	Aug. 29	48	Sept. 5	7	55
1965	July 14	Aug. 21	38	Aug. 26	5	43
2037	July 14	Aug. 23	40	Aug. 29	6	46
2110	July 14	Aug. 25	42	Aug. 31	6	48
2095	July 14	Aug. 26	43	Sept. 1	6	49
2104	July 14	Aug. 28	45	Sept. 3	6	51
2048	July 14	Sept. 1	49	Sept. 8	7	56
1994	July 14	Sept. 1	49	Sept. 7	6	55
2073	July 14	Sept. 1	49	Sept. 8	7	56
2105	July 14	Sept. 2	50	Sept. 10	8	58
1979	July 14	Sept. 3	51	Sept. 12	9	60
2020	July 14	Sept. 20	68	Sept. 28	8	76
2035	July 14	Sept. 22	70	Oct. 2	10	80
3127	July 15	Sept. 17	64	Sept. 27	10	74
2752	July 21	Sept. 1	42	Sept. 9	8	50
2751	July 21	Sept. 5	46	Sept. 13	8	54
2797	July 24	Sept. 22	60	Oct. 2	10	70
2986	July 27	Sept. 5	40	Sept. 13	8	48
3004	July 27	Sept. 15	50	Sept. 24	9	59
3005	July 27	Sept. 22	57	Oct. 1	9	66
2985	July 27	Sept. 25	60	Oct. 4	9	69
2990	July 28	Sept. 13	47	Sept. 22	9	56
3052	July 28	Sept. 15	49	Sept. 24	9	58
3090	July 31	Sept. 27	58	Oct. 8	11	69
	Average.....		52.1		7.2	59.2

The average time for 36 individuals in the larval stage proper was 52.1 days, with a maximum of 70 days and a minimum of 40 days. The average prepupal stage for 36 individuals was 7.2 days, with a maximum of 11 days and a minimum of 4 days.

THE PUPA.—The pupa (Pl. 12, fig. 4) is about 15 mm. long and 9 mm. in maximum width. Emergence from the old larval skin is accomplished by splitting the skin first along the epicranial suture and finally almost the full length of the back. In some cases, the pupa remains within the moulted exoskeleton, while in others it twists its way out. When newly transformed, the pupa is creamy white in color but soon darkens



Pyrus gibbosus DeG.: (1) adults; (2) eggs; (3) larva; (4) pupa (ventral view); (5) last ventral segment of female; and (6) last ventral segment of male.

to a light brown, the abdominal segments remaining somewhat lighter than the rest of the body. As a rule, the pupa lies on its back. The only movement discernable is a slight twisting of the abdomen. Secondary sexual characters (to be described later) can be seen through the pupal skin and the sexes are thus easily determined in this stage. The average length of the pupal period was found to be 19.1 days, with a maximum of 29 days and a minimum of 11 days. The first pupa of the season was found on July 30, and the last near the end of October.

THE ADULT.—The adult (Pl. 12, fig. 1) is a large, cumbersome, brown beetle, often mistaken for one of the June-bugs or May-beetles, although the circular depression of the thorax with its small tubercle and the strongly punctured elytra easily distinguishes it from them. The size varies from 11 mm. to 16 mm., the males usually, though not always, being the smaller.

L. gibbosus may be described as follows: robust, convex, rather broadly oval, slightly wider posteriorly, reddish-brown to blackish, somewhat paler on ventral surface, moderately shining. Mandibles three-toothed on outer edge. Labial palpi inserted at sides of mentum. Antennæ lamellate, 10-jointed. Clypeus subtriangular, bidentate at distal edge, proximal margin with transverse carina. Clypeus and head with large confluent punctures. Eyes finely granulated, outer margin of head in front of eyes distinctly carinated. Thorax wider than long, sides regularly rounded from base to apex, margin slightly reflexed. A small tubercle at apex, followed caudad by a large circular depression. Surface finely punctate, punctures sparse and irregularly placed. Ventral surface of thorax and legs with long, dense, brown hairs. A small tubercle directly behind front coxæ. Anterior tibiæ tridentate. Middle and posterior tibiæ, each with two pubescent carina on outer edge, giving appearance of extra corbels. Punctures of elytra coarser than those of thorax, in nearly regular rows on disk, at sides irregular. Scutellum very sparsely punctured. Elytra subtruncate at tip. Pygidium exposed, triangular, finely and sparsely punctate. Ventral segments of abdomen smooth, shining, each with more or less distinct transverse row or setigerous punctures near outer margins. Distal margin of last ventral segment of male distinctly emarginate; of female, broadly rounded.

The sexes are distinguished by the characters of the last ventral abdominal segment. In the male, there is a distinct emargination at the distal end of this segment, while in the female its margin is obtusely rounded (Pl. 12, fig. 5–6).

When handled, the adults often excrete a white viscid fluid from the posterior end of the abdomen. They will extrude this liquid even when freshly transformed from the pupa. At this time the elytra are creamy white but change in a few hours to the characteristic brown color.

The beetles are attracted to lights at night. During the day, they burrow into the soil or hide beneath such objects on the ground as will give them shelter from the light. Mating occurs underground and in the darkness of these hiding places. During the past year, overwin-

tering adults were taken at lights as early as May 4, from which time on they were abundant until June 11. None were taken after this date until August 3. The lapse of time between these collections indicates a distinct separation of broods at Manhattan, although collections made throughout the summer at Junction City, Kansas, seem to indicate a distinct overlapping of broods at that place. The adults, which hibernate in the soil at depths ranging from six inches to four feet, emerge during the first warm nights of the following spring.

Summing up the life-history of *L. gibbosus*, adults are present in the soil throughout the winter and early spring. During the latter part of April, or the first few days of May, and continuing throughout the summer, they emerge at night and fly to lights, returning to the soil before daybreak. During the summer of 1916, eggs were plentiful at Manhattan from the last of May to late in July. Larvæ were present from June throughout the remainder of the summer and early fall, and pupæ from the last of July to the last of October.

Natural Enemies

The common toad (*Bufo americana*) is an important predaceous enemy of the adults, especially at night while they are flying at lights. Riley and Howard (1886, p. 189) cite the chuck-will's-widow as an enemy. Beal (1900, p. 70; 1911, p. 56) found adults in the stomachs of the crow blackbird and the flicker, while Judd (1902, p. 103; 1905, p. 41) found them in the warbler and mentions feeding the beetles to bobwhites.

During the past summer, three species of sarcophagid flies, *Sarcophaga helicis* Tns., *S. cimbicis* Tns., and *S. rudis* Ald. (MS.),[1] emerged from dead adults. The larvæ of the three parasites probably leave the dead adults when mature and pupate in the soil.

The grubs are attacked by what appears to be two distinct bacterial diseases, one of which produces pink and the other black lesions on the body. In rearing cages, fungi attack and kill many of the grubs.

Remedial Measures

No satisfactory method of control can be given for this species. Fall plowing, unless it be done early enough to break up the pupal cells, is practically useless, for the adults, when disturbed, can easily dig back into the loosened soil. The time of pupation extends over so long a period that no special time could be set to destroy the pupa by plowing.

Because of the preference of both the grubs and beetles for soil rich in decaying matter, it is evidently advisable, in regions where corn is damaged, not to plant corn in freshly broken pasture land.

[1] Determined by Dr. J. M. Aldrich, of the U. S. Bureau of Entomology.

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[1] Paper not seen by the writer.

ON THE LIFE-HISTORY AND SUCCESSFUL INTRODUCTION INTO THE UNITED STATES OF THE SICILIAN MEALY-BUG PARASITE[1]

By HARRY SCOTT SMITH

The Citrus Mealy-bug (*Pseudococcus citri* (Risso)) has been known to entomologists for many years as a troublesome greenhouse pest. It is only in comparatively recent times, however, that it has become an insect of economic importance in the orchard. In Florida it has been known as an out-door pest for some time. In California its first appearance as an enemy of orchards is obscure, although it was familiar on citrus in San Diego county as early as 1880. Since 1908 it has assumed a position of great importance in this state in the orange and lemon groves and much investigational work has been carried on in the attempt to control it. Up to the present time no great success has been achieved in this line, since it does not succumb readily to any of the methods of spraying and fumigation which are successfully used against other coccids found in citrus orchards.

There are a number of enemies of the Citrus Mealy-bug in California, some of which are of great importance at times. The most effective of these are the Brown Lacewings (*Sympherobius californicus* Banks and others). *Leucopis bella* Lœw is occasionally of importance, and *Cryptolœmus montrouzieri*, a ladybird which was introduced by Kœbele in the early nineties, at times renders great service close to the seacoast. There is only one internal parasite which is at all common, that is *Chrysoplatycerus splendens* (Howard), an Encyrtid which attacks the half-grown to full-grown mealy-bugs. It is of very little economic importance, however, since it breeds slowly and is local in its distribution.

During the summer of 1914 the California State Horticultural Commission maintained a laboratory at Palermo, Sicily, for the purpose of obtaining and introducing into this state any promising enemies of the Citrus Mealy-bug or of the Black Scale which might be found there. The collecting of mealy-bugs was undertaken by Mr. Henry L. Viereck and several shipments of these insects were forwarded to Sacramento. From one of these lots of mealy-bugs we were successful in rearing a few specimens of the odd little parasite which forms the subject of this paper. These were placed in a cage containing lemons infested with mealy-bugs and breeding took place with rapidity. Before many months we were enabled to place large colonies in the orchards of southern California.

[1] Occasional contributions from the California State Insectary No. 4.

Identity of the Species

This parasite was at first thought to be a species of the genus *Leptomastix*, a genus of which there have been recorded three species, one having the mealy-bug as its host. The insect was later studied by Mr. Girault, however, through the courtesy of Dr. Howard. He found it to represent a new species in the genus *Paraleptomastix*, which he had only a short time before described. He named the species *abnormis* and it was described in the *Entomologist* (London), vol. 48, pp. 184–185. It is one of the ectromine Encyrtids, in which group occur a number of important coccid parasites.

The Adult

The adult of *Paraleptomastix abnormis* Girault is very striking in appearance, due to its peculiar habit of holding its wings aloft when walking about, as is shown in the illustration. One wing is held in such a manner that it appears to be broken at the base. The peculiar banded wings are the most conspicuous part of the parasite's anatomy and will always serve to identify it among our California scale parasites. For a detailed description I transcribe herewith Mr. Girault's original characterization.

Female.—Length, 1.00 mm.

Differs from the description of the genotype in being like species of *Leptomastix* except that the postmarginal vein is elongate, a third longer than the lender stigmal, and over thrice the length of the marginal, the latter barely twice longer than wide.

Golden yellow—often dusky yellow—marked with dusky black as follows: Distal half to two-thirds of the abdomen, bulb of scape, cephalic aspect of the last two pairs of coxæ; funicles 1 and 2, club, proximal two-thirds of pedicel above, a conspicuous streak along the dorsal scape for its entire length, dorso-lateral edge; and frequently the entire disk of pronotum and scutum. Rest of antennæ pallid dusky, the scape, abdomen, pedicel, pro- and mesopleurum silvery. Propodeum blackish except laterad of the spiracle. Venation dusky. Apex of caudal wing and a longitudinal oblique streak opposite the submarginal vein, dusky. Fore wing conspicuously trifasciate, the first cross-stripe smallest, incomplete, obliqued caudo-proximad from before the bend of the submarginal vein; the second is complete, broader caudad, from the postmarginal vein; the third is largest, across just before the apex, not very broad, divided at middle narrowly and obscurely by a less dusky streak. Pedicel somewhat longer than wide at apex, somewhat shorter than funicle 1, which is two and a half times longer than wide; funicles 3 and following each being somewhat longer than 1. Club joints subequal to the pedicel. Head densely scaly punctate. Axillæ with a short carina between them. Scrobes distinct, not joined above. Dorsal thorax with a short silvery pubescence.

The male is about the same, but the third or distal stripe of the fore wing may be nearly absent, usually distinct. The scape is more compressed, the pedicel barely longer than wide, the club solid, the flagellar joints (excluding the pedicel) all somewhat longer and with scattered, rather long hairs, the funicle joints shorter than the club.

Habits of Adult

Paraleptomastix abnormis takes very kindly to domestication and is a very satisfactory parasite with which to work, since it is not affected adversely by confinement. It is industrious in habits and swarms about over infested fruit and plants in a businesslike manner, keeping constantly on the move in its search for a suitable host. It is not easily disturbed and will not fly unless forced to do so. In the orchards where it has become established one to a dozen may be found upon a leaf where they are continually seeking young mealy-bugs.

Oviposition

Oviposition takes place as soon as the adult has emerged and its wings have hardened, so that oögenesis must occur to a large extent before the adult parasite leaves its host. The younger stages of the Citrus Mealy-bug, first and second, are preferred as hosts. I have not observed oviposition in the last stage, although it would probably occur when this stage is forced upon the parasite. In the process of oviposition there is very little preliminary work, the female simply examining the host casually with her antennæ, then turning, inserting the ovipositor into the host's body, and depositing the eggs in a comparatively short period of time. The mealy-bug resents the attack by a considerable amount of squirming, but it is never sufficient to deter the parasite from carrying out her purpose. In nature she apparently places but one egg in a host, or at least one only reaches maturity, but when forced to do so she will deposit as many as 100 eggs in a single mealy-bug.

The Egg

The egg is of the usual oval shape with a minute projection at one end, very inconspicuous as compared with the stalk of many Encyrtid eggs. The egg proper is filled with granular matter which gradually becomes darker and more conspicuous as the embryo develops. There is no visible sculpture. The egg floats about freely in the body cavity of the host and hatching takes place in about five days. The ovarian egg is a quite different appearing object, as the accompanying illustration shows, there being a short neck or stalk with the egg proper at one end, and an enlargement at the other, nearly the size of the portion containing the embryo. This enlargement is transparent and is lost during or immediately after the process of oviposition. The function of this peculiar body is unknown to me, although it probably acts as a

Fig. 9. *Paraleptomastix*, ovarian egg. (Original.)

reservoir of the egg contents at the time of deposition. It is certainly not used as a breathing tube as is the case with many related parasites, since the egg is not attached to the host, but is free in the host's body cavity.

The Young Larva

The newly-hatched larva is without distinguishing characters, being transparent and with very indistinct segmentation, excepting that what might be termed the cephalic segments are set off from the others by a rather distinct suture, giving it somewhat the appearance of a young Ichneumonid larva. The mandibles are exceedingly minute and difficult to see, even with a high power compound microscope. The second stage is similar to the first excepting that the cephalic segments are more conspicuous, as are also the mandibles, and the caudal end is more attenuate, giving it still more the appearance of a young Ichneumonid. The skin of this stage is roughened, making it appear to be covered with minute tubercles. At the caudal end there is frequently a darkened area which may be the first stage moult skin.

Fig. 10. *Paraleptomastix*, 2d stage larva. (Original.)

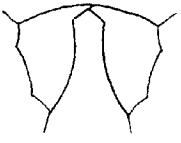


Fig. 11. *Paraleptomastix*, 2d stage, mandibles. (Original.)

The Mature Larva

The full-grown larva is of the usual Encyrtid type, with nothing characteristic excepting its mandibles. These are much larger and more conspicuous than in the second stage and slightly different in shape. It now rapidly devours the entire contents of its host's body which is killed in the process, the latter becoming much extended and cylindrical in shape so that it is easily distinguished from a healthy mealy-bug. The host now turns to an amber color and under the microscope the larva may be observed through the skin of the host. A condition is assumed very similar to a "mummified" aphid. These "mummies" are very characteristic and may be found in great clusters in the cage or orchard where the parasite is abundant.

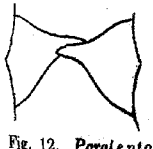


Fig. 12. *Paraleptomastix*, last stage, mandibles. (Original.)

The Pupa

The larva discharges its meconium into one end of the host's shell as soon as full-fed and moults for the last time. The pupa is transparent at first, but soon the eyes become pigmented and gradually the entire stage takes on a darker appearance. Emergence is effected by the cutting away of one end of the shell, after which the adult issues, dries itself and is ready for oviposition.

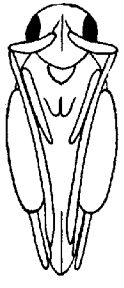


Fig. 13. *Paraleptomastix*, pupa. (Original.)

The entire life-history of this parasite requires from 25 to 45 days, depending upon the temperature.

Sexes and Parthenogenesis

The two sexes are about equally divided as to numbers, although the females are slightly in excess. While copulation takes place freely, this parasite, in common with most if not all Encyrtids, can reproduce parthenogenetically. In this case the progeny are males only.

Hosts

The principal host is the common mealy-bug *Pseudococcus citri* (Risso). While it occasionally will deposit eggs in the related species, *Pseudococcus bakeri*, I have never succeeded in rearing it on that host, the young parasites probably being destroyed by phagocytosis. Mr. O. H. Swezey of the Hawaiian Sugar Planters Station informs me that he has succeeded in getting it to breed upon the Sugar-cane Mealy-bug *Pseudococcus sacchari*, but it does not thrive greatly on that species.

Method of Rearing for Life-History Study

The most convenient way of rearing this and other parasites of *Pseudococcus citri* in the laboratory for life-history work has been found to be the use of infested green lemons. These are placed in a cage composed of a plaster of Paris base, into which is embedded a coil of wire which forms a support for the lemon. Over the lemon is placed a glass cylinder or chimney with a gauze or tissue paper top which permits of ventilation. A sufficient amount of moisture is usually supplied by the evaporation from the lemon. If the lemon tends to dry up, moisture may be added by placing the plaster base in a basin of water.

Rearing for Orchard Colonization

For orchard colonization it is of course desirable to rear these parasites in large numbers and this has been successfully accomplished by the use of both lemons and potato sprouts. For the latter method trays three inches deep and about sixteen inches square are filled with

a layer of potatoes and the interspaces filled with moistened sand. These trays are put in a warm dark place and sprouting occurs in a short time. Mealy-bugs are then introduced and breeding takes place very rapidly. These trays are made so that they will fit interchangeably in the breeding cages. In order to supply new host material in any breeding cage, it is only necessary to place the older tray on the lower shelf, with the fresh tray above. In this way all the parasites which may occur on the old tray as young larvæ or pupæ within the mealy-bugs are retained. This process of shifting the trays downward as each fresh tray is added, is continued until all parasites have reached maturity, when the older material is discarded. By this method we have been able to take thousands of adult parasites daily from the breeding cages for liberation in the orchards.

Handling and Shipment of Parasites for Colonization

The adults are collected from the cloth walls and top of the cage by use of a glass cylinder about two inches in diameter and eight inches long. This is provided with a cork at one end into which is inserted a short piece of 8 mm. glass tubing. This tube projects through the cork on the inside of the glass cylinder in such a way as to prevent the escape of the captured parasites. The cylinder itself is lightly filled with finely shredded paper upon which the parasites may rest. They are shipped or taken in person to the field colonies in these cylinders. When shipped by mail the cylinder is wrapped in moist sphagnum moss and this is then packed in a pasteboard box in its entirety. The method is very satisfactory for shipment within the state, but when sent to points outside the infested mealy-bugs themselves are forwarded, since the adult parasites do not survive a long hard journey. When colonizing the parasites in the orchard the cylinder is usually tied horizontally in a crotch of the tree and both corks removed. This prevents injury from storms. Where possible, not less than five to ten thousand are placed in a single colony.

Present Distribution

This parasite has been distributed pretty thoroughly throughout the mealy-bug infested sections of the state and has become established in practically every colony. The principal regions are the counties of Los Angeles, San Diego, Ventura, Santa Barbara, and Yuba, the latter in the northern part of the state, the former all south of the Tehachapi mountains. The species has also been sent to the Hawaiian Islands and to Florida.

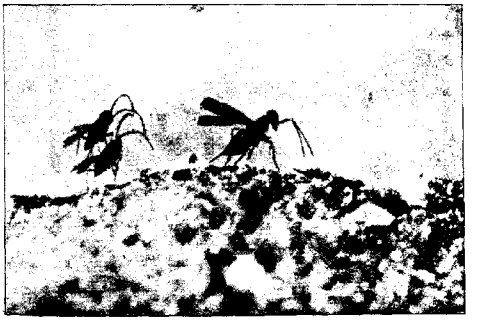
Economic Importance of Paraleptomastix abnormis

There are at least two important general requirements which a parasite must fulfill if it is to become of value in the control of its host and

the measure of success it will achieve will depend largely upon how completely these requirements are fulfilled. In the first place it must fill a gap in the natural control of the host insect, that is to say it must not attack a stage of the host that is already subject to heavy attack by other parasites. In other words, it must form a new element in the biological complex surrounding the pest. The second requirement is that it must be able to adapt itself and thrive under its new environment, not only in relation to climate but in relation to artificial conditions which are brought about by man. At the present time *Paralep-tomastix abnormis* seems to be all that could be desired in this direction. There is no parasite occurring in California which effectively destroys the first and second stages of the mealy-bug. These are eaten to a large extent by predaceous insects, but the parasitised individuals after they have reached a certain degree of development are refused by these predators. This has been observed frequently in the orchard, large numbers of the mummies being found in trees where the mealy-bugs are severely attacked by ladybirds and lace-wings. Its adaptation to environmental conditions is almost perfect. Coming from Sicily, it finds here a climate almost the exact duplicate of the one where it originated. By passing through two winters quite as severe as the average—if one may correctly speak of a California winter as severe—it has proven itself able to withstand our lowest temperature. At Marysville, adults were collected in large numbers a week after two freezes. It has also proven its ability to undergo successfully the hot dry summers of the interior valleys of this state. In our citrus orchards, many of which are infested by Black, Red and Purple Scale, it must be able to survive fumigation for those pests. In many of the orchards under observation it has successfully passed through two fumigations, probably as larvæ and pupæ within the young mealy-bugs. Spraying does not destroy it, excepting where it is successful in killing the mealy-bugs.

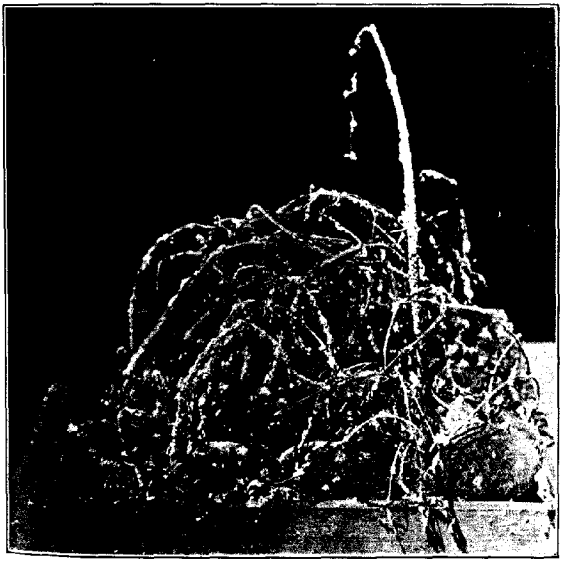
The question now arises as to what we may rightfully expect from the introduction of this parasite. It is now thriving and increasing rapidly in all the field colonies. The remarkable way in which it has increased during the short time since it has been introduced, the fact that it has proven itself adapted to environmental conditions, and the fact that it fills a gap in the natural control of the host, justifies, I believe, the hope that it will become of great economic value. It is too much, of course, to expect that this parasite alone will be able entirely to control the Citrus Mealy-bug, but its introduction will certainly prove an important step toward that desired end. Time alone will show its true worth to the citrus industry.

Adult of *Paraleptomastix* on the surface of a lemon. Greatly enlarged. (From Viereck, Mon. Bul., State Hort. Comm.)



Paraleptomastix abnormis, male and female. (Original photograph from life.)

Cages used in life-history work. (From Viereck, Mon. Bul., State Hort. Comm.)



Mealy-bug-infested potato sprouts, used in propagation of parasites. (From Branigan, Mon. Bul., State Hort. Comm.)

SOME PROBLEMS IN INSECT CONTROL ABOUT ABATTOIRS AND PACKING HOUSES[1]

By F. C. BISHOPP, *U. S. Department of Agriculture, Bureau of Entomology*

INTRODUCTORY

The attitude of the public in general toward the source and method of production of its food supplies had been largely a passive one. An increased interest along these lines is being exhibited and improved methods of handling foodstuffs are in evidence. Nowhere have rules of sanitation been more grossly abused than in the preparation and handling of foods of animal origin which constitute so large a part of the diet of the American people. The action of federal, state and municipal authorities has brought about during the last decade marked improvement of sanitary conditions under which meat food products are produced. While these activities have not always involved campaigns against flies they have always resulted in affecting fly control in some degree. Possibly the greatest advance along the line of improving the quality and cleanliness of this group of products has been made by the operation of the federal meat inspection act as carried out by the United States Bureau of Animal Industry.

The question of producing animal products in a sanitary way has many sides, and the meat inspection service has been ever awake to the possibilities of improving in various and sundry ways the efficiency of their service. The question of fly control has received no little attention from them, but many problems of a special nature arose which resulted in the request that the Bureau of Entomology coöperate with them in the study of the relation of insects to the packing industry.

Mr. George H. Shaw, Sanitary Engineer of the Bureau of Animal Industry, working under the general direction of Dr. R. P. Steddom, chief of the meat inspection division, had given the question of fly repression some attention before the Bureau of Entomology took up the work, and these gentlemen, as well as inspectors in charge of federal meat inspection in different parts of the country, have shown hearty coöperation in the conduct of the investigation which has been carried on for the greater part of two seasons by Mr. E. W. Laake and the writer.

One of the encouraging features of the work is the general acceptance as an unquestioned fact that flies and other food-infesting insects are a menace to public health and should be controlled. This speaks highly of the educational propaganda along this line which Dr. L. O. Howard has been foremost in promoting. Nearly all of the fed-

[1] Published by permission of the chief of the Bureau of Entomology.

eral inspectors and many of the officers of the packing establishments have shown interest in the question of insect control about the respective establishments. In many cases the packers are inclined to delay putting into force measures recommended and attempt to justify their attitude with the statement that little can be done toward control as long as municipalities immediately surrounding them do nothing along this line. In many other instances, however, the superintendents of meat packing plants have coöperated heartily in all control work undertaken. The work, in so far as it appertains to establishments under federal control, is progressing very satisfactorily. It might be mentioned that this is one of a few instances where recommendations looking toward the control of insects can be successfully put into effect by law, but here, as in most other cases, educational work can be largely depended upon to bring results.

Some of the Special Ppoblems Involved

In general, it is found that the packing houses under bad fly conditions produce the major part of the flies and other insects which give annoyance about the respective premises. On the other hand, when these plants eliminate practically all breeding places, flies still exist in considerable numbers and it must be conceded that large numbers come from surrounding breeding grounds not under the control of the establishments. Unfortunately, many packing houses are located in districts where the conditions are favorable to insects and in turn the establishments themselves tend to produce this class of conditions in their environs. In some cases portions of cities abutting the packing house and stock yards districts are inadequately provided with sewers and many other insanitary conditions prevail. It has also been observed that city dumping grounds, where all sorts of refuse is accumulated and flies are bred in myriads, often are not far removed from slaughter house districts. The houses themselves, on account of the production of various types of attractive odors, seem to have a tendency to center the flies from all of these outlying districts in their immediate environs. Hence the proprietors and operators are confronted

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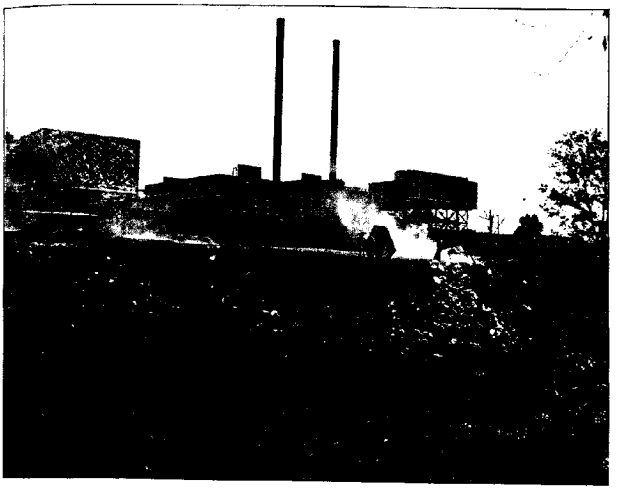
Explanation of Plate 15

1. Dump at slaughter house showing method of filling low places with paunch manure and other refuse. Note the roughened appearance of pile at left due to burning of dry portions, and smoke from fire at right. Unfortunately burning of fresh material which will produce flies in great numbers is difficult under out-door conditions.

2. Small rendering plant where fly conditions are very bad. Note offal on platform with open bin containing bones behind it. The meat is largely disposed of by maggots. Photographs by H. P. Wood. (Original.)



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with a problem not only of preventing the breeding of flies on their own premises, but of destroying those which are so freely contributed by surrounding breeding places. In addition to those insanitary conditions mentioned, it is not infrequent to find rendering plants, both for garbage and dead animals, glue works, fertilizer factories and city sewer discharges located in the same districts. Fortunately, engineers have devised means of greatly reducing the amount of odor given off by the various manufacturing processes involved, and still further development along this line in under way. This should render not only the establishments less attractive to flies, but should also aid in improving city conditions in the vicinity of such plants.

Another condition, which is somewhat different from that encountered in most fly control work, is the accumulation of large amounts of material of vastly different kinds which, when not receiving proper attention, produces abundant breeding places for many species of insects. For example, it was formerly not uncommon to find on some packing house premises, enormous piles of manure from cattle paunch —in some cases several hundred feet long—tons of undried blood and meat tankage often infested with maggots when shipped in from smaller plants, carloads of bones of various kinds which furnished admirable breeding conditions for a number of species of blow-flies, thousands of sheep pelts which in some cases were air-dried and bred flies during the process, warehouses full of hoofs, horns and various classes of dried bones which produced swarms of hide and ham beetles as well as skipper-flies. In the immediate environs of slaughter plants it was formerly the practice to dry hog hair on the ground. In some instances acres of hair fields were found, and during the drying these bred numbers of flies beyond comprehension. Sometimes great areas exist in the vicinity which are covered with manure removed from stock yards and in cleaning cars. Numerous temporary breeding places are produced by the breaking or clogging of pipes or boiling over of stick-water vats which may render many square yards of earth suitable for breeding myriads of flies. In some of the large plants the fertilizer industry is carried on in large proportions. The receipt of many cars of dried bones at such establishments is not uncommon, and we have found these to be fertile breeding places for the so-called skipper-fly. Many other conditions favorable for fly attraction and breeding might be cited.

There are some advantages in the usual grouping together of a number of packing establishments in one district, for in these cases the operators usually have complete control of such districts and if they assume the proper attitude much beneficial work can be done through them. While the meat inspection service does not exercise direct

control over the stock yards, in a number of important centers the establishment proprietors own a controlling interest in these yards and hence much improvement can be brought about if their attention is directed to the existence of insanitary conditions in such yards. This applies more especially to the larger establishments, nearly all of which are under government inspection.

In those plants which are under proper supervision an opportunity is afforded for systematic efforts toward the immediate alleviation and ultimate elimination of these conditions. A somewhat different and much more serious set of conditions prevail at the small slaughter houses not under inspection. In nearly all these no facilities are provided for the utilization of any of the offal or manufacture of any by-products which results in the production of exceedingly insanitary conditions instead of giving clean premises and a substantial financial return. In some instances hogs are yarded around the uninspected slaughter houses where they feed upon the blood and offal, and thus are subjected to dangers of infection with tuberculosis and other diseases, as well as internal parasites, to say nothing of the indescribable fly-breeding conditions produced. The wallows made interfere with drainage and the blood and remaining portions of entrails, bones, etc., accumulate in the surface mud and sometimes render the entire pen a prolific fly-breeding ground. In other instances the maggots and bacteria are depended upon to dispose of the entrails and clean the bones. Usually the flies emerging from their filthy environment have ready access to the slaughter house, the interior of which is usually in keeping with the outdoor conditions. Little or no effort is usually made to prevent flies in countless numbers from swarming over the freshly skinned animals, but some precautions, such as killing late in the evening or the generation of smudges, are necessary to prevent the blowing of the meat, which, nevertheless, frequently occurs. These crude steps are taken not for sanitary reasons so much as to avoid loss from trimming or the danger of the meat exhibiting to the prospective buyer some gross evidence of the very obnoxious conditions under which it was prepared.

Species of Insects Concerned

The insects which cause trouble about packing houses may be divided into three groups: The Diptera—including house-flies, blow-flies and others; the cockroaches, and ham and hide beetles. From the point of view of the packer and the sanitarian, the house-fly and various species of blow-flies are of by far the greatest importance. The season of the activity of blow-flies is somewhat greater than that of the house-fly on account of the varied seasonal habits of the different

species concerned. In general, it may be said that the blow-flies give greatest annoyance about the inedible departments of the establishments and where fresh blood is present. While the house-flies also exist under these conditions they are found in greatest numbers about the portions of the plants where the finished products are to be found. They are especially numerous about the various loading docks and in sausage rooms. House-flies may also give annoyance in certain departments where scarcely a blow-fly is to be seen. They are also very troublesome in the wholesale markets connected with the packing establishments. Although the kind and number of blow-flies vary somewhat in different regions, it may be said, in a general way, that the common black blow-fly, *Phormia regina*, is the most troublesome of this group. In the middle of the season it is often supplemented or replaced by the green-flies, *Lucilia cæsar* and *L. sericata*, and occurring with it is the large bluebottle-fly, *Cynomyia cadaverina*, and several species of Calliphora, notably *erythrocephala, vomitoria, coloradensis*, and *iridescens*. In the South the screw-worm-fly, *Chrysomyia macellaria*, often becomes excessively abundant during the summer season, while the other species mentioned are greatly reduced in numbers or entirely disappear. Several species of Sarcophagids are also in evidence during the summer months, but they are usually not present in great numbers and seem less prone to enter buildings. The black anthomyid flies, *Ophyra aenescens* and *O. leucostoma*, are sometimes present in considerable numbers, but are to be found only rarely within buildings. The former of these is found only in the Southern States. *Fannia canicularis* and *scalaris* are common, but are not given to free visits to animal products. The skipper-fly, *Piophila casei*, is usually present during the summer months about nearly every establishment, but on account of the care exercised in protecting cured meats it is seldom of any particular importance except in branch houses where it often causes considerable loss.

The three species of cockroaches commonly found in the United States are present in greater or less numbers about packing houses. Their abundance and the consequent danger of contamination of food products by them is greatly lessened by the construction of buildings of steel, concrete and brick. In some of the older plants they are a source of much annoyance.

The ham and hide beetles, like the skipper-fly, seldom do any material damage to products about the establishments, due to care exercised in handling material subject to their attack. They have been reported as doing considerable damage to products in branch houses and about small establishments not under government supervision.

Lines Followed in Control

It has been the practice of packing concerns heretofore to spend all the funds used improving the appearance of their premises on the front of the grounds. This plan is being changed considerably and much attention is given to the cleaning and beautifying of the interior portions of the grounds.

On account of the conditions mentioned in the preceding pages it has been found necessary to practice nearly all known means of fly control. The first consideration is to abolish breeding places. This demands many permanent improvements. It has been found best, from the standpoint of the operator as well as from the sanitarian's point of view, to permanently abolish in so far as possible all breeding places rather than to depend on giving them constant attention. As illustrations of the permanent improvements desirable may be given the construction of good buildings for all manufacturing processes, especially where tanking and other work which is conducive to the attraction and breeding of flies is done. This permits of thorough cleaning in these inedible departments as well as in the portions of the plant where products intended for food are handled. The installation of modern equipment with ample capacity for use in such processes as tankage drying, hair drying and bone drying, and also a provision for ample storage room. The concreting of horse stalls and holding pens for stock and areas where paunch manure, stable manure and hog hair are loaded are usually necessary to attain the ends desired. The prompt shipment of manure and undried hog hair, green bones and hides should be insisted upon when this method of disposal is followed. When hog hair, horns, hoofs and bones are dried at the plant this must be done promptly and thoroughly. The proper tanking of bones has also been found to decrease the amount of fly breeding in this class of material, especially if the bone tankage is stored under roof.

Probably the most important single improvement which can be installed is an incinerator with a capacity sufficient to handle all refuse, such as paunch manure, stable manure, settlings from catch basins, and damaged crates and other containers, soiled wrappers and sawdust, all of which are attractive to flies. The question of the installation of incinerators is one which deserves consideration by every municipality, as well as the packing houses.

When all possible breeding places have been eliminated there still exist some places—usually of a temporary nature—which must be treated for the destruction of maggots and the prevention of egg-laying by the flies. It has been found that often a very small leak in a blood conveyor or stick water tank will produce favorable breeding places

in the soil adjacent for great numbers of flies, and accidents leading to the infestation of the ground or in case of accumulation of temporary breeding materials it is necessary to use some larvicide. Crude petroleum has been found very helpful in preventing breeding in these temporary situations. Where the amount of the breeding material is large, however, the oil does not succeed in killing all of the maggots unless applied very freely and frequently. The application of crude petroleum to the grounds of the packing houses also aids in keeping down dust, which is an additional good feature. Where incineration is not practiced, the use of borax on paunch manure and other breeding media has been found satisfactory. It is also effective in treating temporary breeding places of various types. It has been used at about the same rate as that recommended for the treatment of stable manure. The prompt covering of breeding materials on dumps with fuller's earth, which has been discarded after use in lard refining, has been found to check fly breeding materially, but should be employed only as a supplemental or temporary measure.

On account of the attractiveness to flies of abattoirs and packing establishments we hold that fly traps fill a very distinct place in control work under such conditions. While the Hodge type window trap has been found of some value under certain conditions, in general it seems best to attempt to attract the flies into traps on the outside of the building rather than to catch them in the windows or within the departments. The kind of bait used has to be modified to suit the conditions and the species of flies present. The mucous membranes from hog intestines (a by-product of sausage casing manufacture) has been found to be by far the most attractive bait for blow-flies, and also catches a large percentage of house-flies. On account of its odor this material cannot be used around edible departments and in front of the establishments. As has been explained, the house-fly predominates in such situations and therefore stale beer or some other good house-fly bait is satisfactory in these situations. The simple conical trap as described by the Department has been found most effective and durable.

In wholesale markets and departments where edible products are manufactured, it is important that practically all flies be excluded. For this purpose, window screening is largely employed, but under conditions which often exist these are not sufficient as the flies gain entrance through doors which are being opened very frequently. Blowing devices have been employed in such passage-ways with some success, and Hodge traps or fly exits through the window screens are helpful in keeping the number of flies on the inside to a minimum. Other difficulties in fly exclusion are met with in keeping flies from

entering through the chutes with the live stock. Some inspectors have found it possible to exclude most flies by providing a considerable darkened space before the cattle enter the knocking pens.

The question of reducing odors, which has been touched upon, is an important one. It had been found that flies are attracted considerable distances on account of the odor produced by packing establishments, and it is believed that the number of flies attracted is largely in proportion to the volume of this odor.

The methods of handling finished edible products often have to be modified considerably to avoid contamination from flies. The prompt passage of the carcasses into the coolers is an important step, and the covering of various products also helps to maintain a higher degree of cleanliness. Thus much fresh meat is provided with light coverings, hams and sausages are wrapped with care and attention is given to the protection from fly contamination of meats when on wagons.

It is not infrequent that shipments of hams and bacon held for some time in branch houses become infested with skipper-flies and these are returned to the producing house. On account of the fear of introducing this pest into the storage rooms, the packers usually destroy such meats immediately regardless of the extent of infestation. This causes a considerable loss which might be avoided. The loss from ham beetles is of similar nature. The proper wrapping of these materials reduces the chances of infestation and it is important that they be stored in clean, dry rooms carefully screened with fine mesh wire.

Cockroach control depends to a considerable extent upon the conditions of the buildings. The number of roaches is always greatly reduced in modern structures free from wood, and under such conditions there is seldom any trouble owing to the common practice of freely using hot water and steam in cleaning up all departments. Storage rooms are sometimes infested, and under these and certain other conditions the use of sodium fluoride can be depended upon to eliminate the trouble very shortly.

In conclusion, a word more should be said about the sanitary conditions of establishments under government inspection and those without adequate inspection. While meat bearing the stamp of government inspection is sometimes sold slightly higher than uninspected meat, there is certainly a marked difference in the value of the product, from the standpoint of the consumer, and possibly some difference in the cost of production. It may be of interest to know that the Bureau of Animal Industry reports that over 62,000,000 animals were inspected in the 875 establishments under government inspection during the fiscal year ending July 1, 1916. It is estimated that over 40,000,000 animals are slaughtered on the farm and by small butchers, all of

which received no inspection. On account of the intermittent killing on farms, the fly conditions there are far less objectionable than in the small slaughter houses. The fly conditions in most abattoirs not under inspection are beyond description, and one need but to pass through one of these and one of those plants receiving proper inspection to be convinced of the undesirability of buying uninspected products and the need of state or municipal control over such establishments. It may be said that most of the fly control measures found applicable for use in government inspected plants are equally so in the uninspected ones though some modification is often necessary. The first step toward mitigation of the fly trouble is to secure effective supervision and control over such plants. Where incineration is not feasible, prompt burial under two feet of soil after the offal has been sprinkled with borax, the thorough screening of buildings and the installation of covered drains will accomplish much in reduction of fly numbers.

WORK ON WHITE PINE BLISTER RUST IN MINNESOTA, 1916

By F. L. WASHBURN

Abstract

The rust has been discovered in four places only along the eastern boundary of Minnesota, close to the St. Croix river, two of which are nursery infections. One of these nurserymen is known to have brought diseased trees from an old nursery in Wisconsin, just across the river, said trees being a portion of a lot shipped through Hill of Dundee, Ill., to a Wisconsin nurseryman in 1908 or 1909. We have worked in close coöperation with the Plant Pathology Department, aided in part by the State Forestry Service. Camp was established on the St. Croix river, and scouting under the direction of the State Entomologist was carried on up and down the river for a distance of about fifty miles, with the results as above stated. In the two nurseries mentioned, all five-leaf pines and all currants and gooseberries were destroyed by burning, said nurseries being under quarantine as regards this material until destruction of same. Shipments from these nurseries designated as "leads" were traced and destroyed wherever the slightest suspicion was entertained of the presence of blister rust. In the neighborhood of Dry Creek eradication area was outlined and all Ribes within the area as far as possible destroyed by workmen and experts in the employ part of the time by the State Entomologist and a portion of the time by the federal government, although federal funds

were used more particularly in the survey work. Precautions were taken to prevent the spread of spores on the part of workmen by spraying the workmen at the end of working procedures with a weak solution of formaldehyde. All four of these infections lay within a distance of 50 miles along the St. Croix river. The last infection at Pine Hollow Creek was found late in the season at the time of the first frosts, so eradication of Ribes at that time was not practical.

We believe Minnesota has a reasonable hope of eradicating the disease within its borders, and to that end the legislature is being pushed, and appropriation asked for from our state legislature. In planning the work for next year, we are promised coöperation on the part of Wisconsin authorities and it has been recommended that the work in Minnesota be arranged in such a way as to give to the Plant Pathologist with the coöperation of the State Forest Service, the eradication of diseased or dangerous material along the St. Croix, and survey and eradication in nurseries, parks and cemeteries and private plantings to the State Entomologist.

(This address was illustrated by lantern slides.)

NOTES ON AN INTRODUCED WEEVIL (CEUTORHYNCHUS MARGINATUS PAYK.)

By J. A. Hyslop, *Bureau of Entomology, Washington, D. C.*

In sweepings from a mixed meadow at Bridgeport, N. Y., on the southern shore of Lake Oneida, early in the spring of 1914, large numbers of a small weevil which I then took to be *Rhinoncus pyrrhopus* Lec., were found, particularly from those parts of the field where weeds predominated. Knowing that *Rhinoncus pyrrhopus* lived in the stems of *Polygonum spp.*, no further attention was given to these beetles.

In May, 1916, while supervising the construction of an experimental tile drainage system at the same point, the writer's attention was called by Messrs. C. E. Ellis and C. D. La Rue of the State School of Forestry, who were then studying the flora of the experimental plat, to some small larvæ feeding on the seed of dandelion (*Taraxacum officinale* Web.). The insects proved to be the European weevil *Ceutorhynchus marginatus* Schonh., at that time unrecorded from this country. Since preparing this paper Blatchley and Leng have published their monumental work on North American Rhynchophora. In this work the species is first recorded from North America, being taken in Massachusetts, etc., and having been reared from dandelion

by Prof. Glen W. Herrick at Ithaca, N. Y. Mr. E. A. Schwarz, of the U. S. National Museum, very kindly determined this material and in doing so remarked that he had collected the adults on Plummer's Island near Washington, D. C., about ten years ago. On reëxamining the material collected in 1914, it also proved to be this beetle and not *Rhinoncus pyrrhopus* for which it was originally mistaken. The outbreak at Bridgeport was very general, nearly every seed head of the dandelion being infested, which seems to indicate that the insect has been established there for several years. Mr. Schwarz's record from Maryland and the records published by Blatchley and Leng indicate a wide distribution in the Eastern States. That this insect should be established for so long a time and in so wide and generally collected a territory and still be unrecorded seemed quite remarkable. The genus contains other species of economic importance, among which might be mentioned *Ceutorhynchus rapæ* Gyll., the common cabbage weevil, *C. quadridens*, another introduced species which Chittenden records attacking radish, cabbage, carrots, etc., on Long Island, and the new species recorded and described by Pierce[1] (*C. lesquellæ* Pierce) which is a serious cabbage pest in Texas. The only published European observations on the habits of this beetle, those of J. H. Kawall published fifty years ago in the *Stettener Entomologische Zeitung*,[2] are so minutely paralleled by our observations that I herewith publish a free translation.

The species *C. marginatus* Payk. was long recognized as a variety of *punctiger* Schonn, the more recent workers now recognize the insects as a distinct species, and from the localities we conclude that the one spoken of by Kawall as *punctiger* was in reality *marginatus* Payk.

"As early as 1859 I had noticed on the seed heads of *Taraxicum officinale* Wigg. (the dandelion), which had split open and spread out their seed feathers, and after the seed had blown away, that the fruit receptacle was often stained with brown on the upper surface and eaten out cavities were to be seen. I had not, however, found the originator of this damage. At last I had the good fortune to find a seed head in an opening in the seed capsule of which a footless whitish maggot had wedged itself. I placed this find in a box but the little animal failed to transform, the maggot shrivelling up probably from lack of moisture. The following year I searched vainly for such larvæ. Eaten out fruit capsules were easily to be found but were always empty. Notwithstanding this I again began the fruitless search in May, 1861. I continued to examine the completely opened heads and also the unopened buds. I then began to examine the seed heads upon which the shrivelled petals were still adhering but which could be knocked off with a very slight touch, these seed heads were still closed.

[1] Journ. Econ. Ent. vol. III, p. 366, 1910.
[2] Stett. Ent. Zeit., vol. XXVIII, p. 118, 1867.

The seed was nearly ripe but had not yet expanded. Here I found the larvæ in the seed capsules, they had eaten out the inner half and themselves occupied the space from which they had removed the contents. I found two or three larvæ in a seed head, these left the seed, as soon as the latter spread out, and fell to the earth into which they crawled and pupated. The development to the imago does not take place in the seed heads. At first I thought I would obtain from these larvæ *Trypeta leontodontis* and hoped to get some accurate information on the metamorphosis of this boring fly about which Löw has said, 'It is for *Trypeta leontodontis* that a very distinct food has been given, not the same it is certain as that of the closely allied species which are placed together here. (Alleg. Nat. Zeit. IV, 1847, p. 295.) The results were very different, however, as these larvæ proved to be coleopterous. The larva is footless with wrinkled folds, the segments being whitish 1½" long, when outstretched in crawling 2" long and ¼" in diameter; head golden brown, mandibles darker, head small and roundish not as wide nor as high as the body; body narrowed from front to back, naked.

"There emerged from larvæ which left the seed heads on the 30th of May, six specimens of a beetle on June the 26th and these were *Cæliodes* (*Cryptorhynchus*) *punctiger* Schh. The time of transformation was from 27 to 28 days. On the 8th of June, 1863, I found ten larvæ of these beetles in the seed head of this plant, and in the heads of the same plant at the same time, I also found the seed eaten out by another larva. These latter are 1½" long, darker than *C. punctiger* with a blackish head, sharply constricted segments and three pair of blackish legs. They wedged themselves very tightly between the seeds and were whitish in color. Rearings of these gave beetles of *Olibrus bicolor*."

On June the 8th, 1916, I collected one hundred and twenty flower heads of dandelion that had but recently finished blooming. The blossom closes tightly (Fig. 14 *g*), just prior to throwing off the withered petals and expanding the seed carriers into the characteristic nebulous globe with which we are so familiar, and it is at this time that the larvæ are most easily found in the flower heads. When the seed heads open, they crawl out, drop to the ground and burrow down about the base of the plant to a depth of approximately one-half inch where they construct small oval earthern cells, which can easily be removed from the surrounding earth without crushing (Fig. 14 *k*), in which they pupate. Infested seed heads can easily be recognized by the black exudations on the outer surface of the calyx (Fig. 14 *g*), probably caused by the entrance of the young larvæ or oviposition. The larvæ feed principally on the seed (Fig. 14 *h*, *i*, *j*) but on several occasions larvæ were found among the withered flower petals. Seventy of these flower heads were dissected to determine the amount of damage the insects were doing. From these dissections we found that the average number of larvæ in a flower head was 3.7, the percentage of seed damages being 27.6.

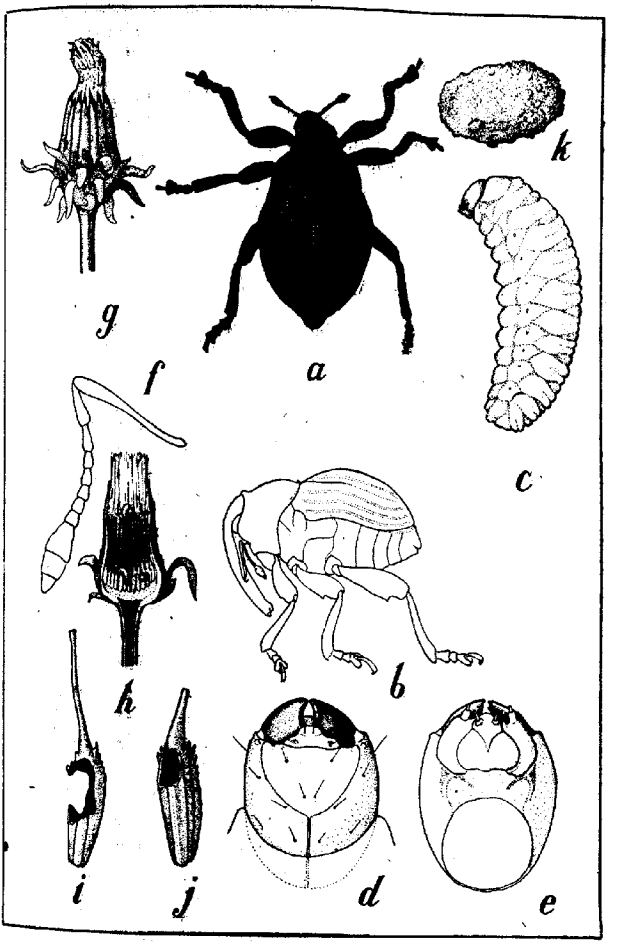

Fig. 14. An imported weevil (*Ceutorhynchus marginatus* Payk.). *a*. Adult, dorsal aspect; *b*. lateral aspect; *c*. larva, lateral aspect; *d*. larval head, dorsal aspect; *e*. ventral aspect; *f*. adult antenna; *g*. dandelion floral head containing weevil larvæ; *h*. [illegible] and *j*. individual damaged seeds; *k*. pupal cell.

By the first of July all the adults had emerged. The locality was revisited on October 20th at which time adult beetles were to be found under the litter at the base of the dandelion plants and undoubtedly these insects hibernate as adults.

An insect which can destroy approximately one-quarter of the seed crop of a noxious weed is no small factor in farm economics. The dandelion, on the other hand, is now quite extensively used as a green vegetable in certain parts of the country and here the insect in question when abundant will be a crop pest.

THE TWO-BANDED FUNGUS BEETLE[1]

By F. H. CHITTENDEN, Sc. D., *In Charge of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

INTRODUCTION

Among species of tenebrionid beetles which habitually frequent mills, granaries, and other storehouses is a species belonging to a different group from any of the several flour beetles, the tribe Diaperini, which is mostly composed of species which live on fungus or dead or decaying vegetable matter—the two-banded fungus beetle (*Alphitophagus bifasciatus* Say). This species, though now cosmopolitan and credited with exotic origin, would appear to be one of the few cosmopolites native to America, from which country it was described by Say in 1824 (1). This origin, however, is decidedly doubtful.

In 1832 it was redescribed by Stephens (2) from England under the name of *Alphitophagus quadripustulatus*, the genus having been especially erected for this species. It has only been in somewhat recent years that the identity of *Phylethus bifasciatus* Say with the European form has been established.

DESCRIPTIVE

THE BEETLE

In appearance this pretty little beetle, shown in Figure 15, resembles some of the fungus-eating Mycetophagidæ, to which family belongs *Typhœa fumata*, an insect of similar habits, more than it does any of the other farinivorous Tenebrionidæ. In form it is elongate oval, convex, depressed, and a little less than one eighth of an inch long. Its color is red brown, with two broad black bands across the elytra or wing-covers.

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[1] Published by permission of the Secretary of Agriculture

Since the writer's experiments on this species seem to establish it as innoxious, its description will be limited to the original characterization of the genus and of the species by Stephens and Say, respectively, which are here transcribed.

The Genus

Genus *Alphitophagus* Steph.

Antennæ slightly elongate, and a little increasing in stoutness to the apex, 11-jointed, basal joint robust, second minute, third and fourth of nearly equal length, slightly elongate, fifth and sixth also equal, stouter and somewhat cup-shaped; four following subquadrate, a little produced within, and thickened at the apex, terminal subglobose, largest. Palpi short, with the terminal joint slightly thickened, somewhat triangular; mentum subcordate; head suborbiculate: thorax transverse, rounded in front, convex: body oval, convex; elytra free; wings ample: legs slender; tibiæ simple, all similar; tarsi heteromerous, with entire joints. (Stephens (2).)

The Species

Alphitophagus bifasciatus Say

Body reddish-brown, punctured: head reddish-black: eyes black: palpi whitish: thorax with a dusky obsolete spot on the middle, and another on each side; angles rounded; punctures very minute, dense: elytra yellowish-fulvous, with punctured striæ; a broad band in the middle, another near the tip, and scutellar region, black: feet pale reddish-brown. (Say (1).)

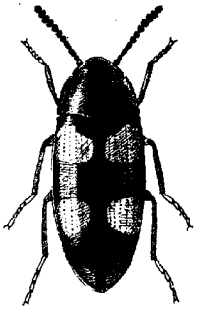

Fig. 15. *Alphitophagus bifasciatus*. (Original.)

Synonymy

The following synonymy is recognized by Seidlitz:

Alphitophagus bifasciatus Say

? *Diaperis bifasciata* Say (1), Journ. Ac. Phil., vol. III, p. 268, 1823.

Diaperis picta Ménétriés (1), Cat. rais., p. 203, 1832.

Alphitophagus quadripustulatus Stephens-Illus., Brit. Ent. Mand., vol. V, p. 12, 1832.

Neomida picta Faldermann-Fauna Transcauc, vol. II, p. 65, 1837.

Phylethus populi Redtenbacher (1), Fauna Austr., p. 589, 1849.

Phylethus quadripustulatus Mulsant (1), Col. Fr. Latig., p. 204, 1854.

Alphitophagus bifasciatus Hamilton (1), Entomologica Americana, vol. VI, 1890.

Biologic Notes

Aside from two notes published in *Insect Life*, (10), (12), the notes in this Bureau are limited. In the writer's personal experience with the species in and about the city of Washington, it has often been found in spoiled cereals and sweepings from the floors of feed stores, and in one instance the writer found specimens, April 29, in spillings of bran and similar material that had fallen through the cracks of a

railway station platform used for the reception of grain, flour, and feed at Branchville, Md.

During July, 1898, correspondence was had with a milling company at Mt. Pleasant, Iowa, in regard to several species of grain insects, of which this insect was one. September 25, 1906, the late M. V. Slingerland sent this species in a lot of mill products from Plattsburg, N. Y. which was also infested by the European grain moth (*Tinea granella* L.).

Mr. Schwarz informs the writer that at Dallas, on the Hood River in Oregon, the species is often found out of doors, being commonly beaten from bushes and found running on the sand, and that in the District of Columbia it inhabits a fungus growing upon trees.

In the streets of Washington, D. C., the beetles occur in great numbers on the window-panes of stores, where they are attracted by the electric lights. The beetles are comparatively active, free runners and flyers.

A number of experiments were made by the writer to ascertain the true habits and life-history of the species. Beetles taken at electric light and placed in dry cornmeal June 13 perished without any larvæ developing. Beetles afterward placed in cornmeal, which was kept moist and in which fermentation took place, lived for a long time and several generations were developed. That a considerable degree of moisture is necessary to this species when in an immature condition was proved when in the course of dry experiments all died and shrivelled up in a very short time. Even a portion of those which were confined in vials fitted with rubber stoppers met with a like fate.

At one time beetles were placed in fermenting cornmeal (May 10) and a new generation was produced in 38 days; the weather being cool, will account for the period.

In a rearing of fermenting meal and flour in which the beetles were placed on June 22, a new generation of beetles was produced in 32 days. During half of this time the weather was unseasonably cool, but it was ascertained by means of a thermometer that the temperature of the rearing jar was about 10° F. warmer than that of the room in which the experiment took place.

The eggs were not observed, but the pupa period was ascertained to be six days in the hot weather of August. Allowing six days for the probable period of the egg, this will give a larval period of between three and four weeks for ordinary summer weather.

Literature

The literature of this species is practically limited to descriptive matter and to brief notices of habits or occurrence.

Mention of its habits was made by Stephens in 1832 (2), who stated that the types of *quadripustulatus* were reared from flour, and that the species was also found "in the decaying floor of a malt house in Cambridge (England)."

Mulsant (4) recorded the capture of the insect under bark; Duval (5) stated that it occurred in débris gathered in a stable; Redtenbacher (6) wrote that it lives under decaying vegetable matter; E. A. Fitch (7) and others that it was found in "corn" (presumably wheat) in storehouses and granaries in England.

Schioedte (9), who gave a description of the larva and pupa with illustrations, states briefly that the species lives in storehouses, in flour and in bread.

What appears to be the earliest mention of its occurrence indoors in the United States is that published by this Bureau in 1889 (10). This is in the form of extracts from correspondence with McPherson & Stevens, Sprague, Wash. Our correspondents stated that this insect seemed to breed under basement floors and to come up and fly away on warm days. The insects did not appear to work in wheat bins but rather in flour dust in dark places. They were stated to be present all the winter and spring and at the time of writing were very numerous.

Several remedies were tried and Persian insect powder was found to be effective.

Prof. L. Bruner, writing in 1893 (11) stated of this species, which he included in a list of insect enemies of small grain, that if it were allowed to increase unmolested it might become a very troublesome pest.

The species is included in a list of insects observed in stored products exhibited at the Columbian Exposition at Chicago, in 1893 (12). The observation was made by Mr. E. A. Schwarz, who noticed the beetles in dried fruit from one of the Central American countries.

Summary

This minute insect as its name, fungus beetle, would indicate, is a feeder on fungi such as molds and has never been actually observed attacking perfectly fresh material. It is a scavenger and is usually found in refuse, such as decaying vegetable matter, in flour and feed stores, in mills and in grain warehouses, and is not uncommon in the open as well as indoors.

It requires a considerable degree of moisture for development and is capable of developing in ordinary summer weather in the District of Columbia in about the same time as other indoor insects of its size—in four to six weeks.

It has been observed in flour, corn meal, bread and under bark and in decaying wood and some other material, including dried fruit. It is cosmopolitan and, although abundant nearly everywhere, is not often reported in great numbers.

Control

As to remedies, the species is hardly worth considering. It has been noted above that Persian insect powder has been found effective. When storehouses, mills, stables and other buildings where stored materials are kept contain other insects which are injurious, this species will, of course, succumb to standard remedies such as fumigants and heat.

It should be unnecessary to add that the insect would not be apt to multiply in any great numbers if scrupulous cleanliness of buildings is maintained.

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FURTHER TRIAL OF SULPHUR-ARSENATE OF LEAD DUST AGAINST THE STRAWBERRY WEEVIL[1]

By THOMAS J. HEADLEE, PH.D., *New Brunswick, N. J.*

Last year before this Association it was shown by the writer that sulphur-arsenate of lead dust when maintained as a rather complete coating from the time bud-cutting begins until most of the buds have opened gives, in the case of the Heritage variety, almost complete protection from the strawberry weevil (*Anthonomus signatus* Say). It was stated at that time also that the protective action seemed to be due to a repellent effect.

The results were so surprising that confirmatory tests were planned for the season of 1916. The tests involved the treatment of strawberries on at least two farms in each of three counties. The plots to which the writer gave most careful attention were located on the farm of Mr. William Oeser of Cologne, N. J.

Mr. Ellwood Douglass ably and conscientiously assisted in the tests at Cologne and took charge of those elsewhere in Atlantic County, while Mr. Warren Oley and Mr. George T. Reid performed the same tasks in Cumberland and Burlington Counties, respectively. While a large measure of protection was obtained in each of the counties included in the tests, the best results were had on the plots on Mr. Oeser's farm.

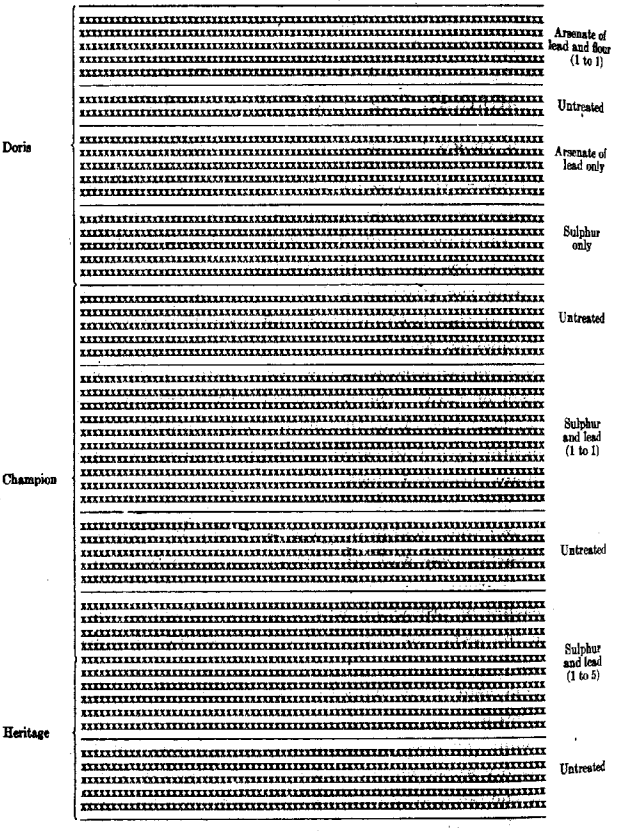
The arrangement of the plots in this test are shown in the accompanying diagram.

At this point the first treatment was given before the Champion buds had hardly appeared and just as injury began on the Heritage. Considering the lateness of the Champion it seemed advisable for the sake of thorough protection to dust three times instead of two as is usual in dealing with a single variety. The dusts were applied with a Tow-Lemons one-man dust gun but the experience with it demonstrated the need for traction or power machinery in dealing with

[1]Contribution No. 2 from the Entomological Laboratory of Rutgers College and the N. J. Agr. Expt. Stations.

large areas. Fairly good results on small areas were had among neighboring farmers by applications through a cheese cloth bag or even by the hand alone.

The results of the treatments in this test are set down on an acre basis although the whole patch amounted to only two acres.



This year the number of buds cut in the treated plots after the treatments began increased to greater extent than it did last year. The writer believe this to be due to less careful covering incidental to making the applications on a commercially practicable plan. The mixtures are shown to be decidedly more effective than either of the

Place	Treatment		Variety	Percentage of buds			Comparative yield	Increase due to treatment	Value	Estimated cost of treatment	Net Return
	Nature	Time		Clean	Stung	Cut					
Cologne	Untreated		Heritage	17.7	31.5	50.7	442 qts. per acre				
Farm of Mr. Wm. Oeser	Arsenate of lead 1 part, sulphur 5 parts	5/6, 5/12, 5/19	Heritage and Champion	62.7	19.2	18.0	2,442 qts. per acre	1,610.5 qts.	$128.84	$12.00	$136.84
	Untreated		Champion	52.7	20.6	26.7	1,221 qts. per acre				
	Arsenate of lead 1 part, sulphur 1 part	5/6, 5/12, 5/19	Champion	78.	12.2	9.0	2,604 qts. per acre	1,532 qts.	$122.56	$24.00	$98.56
	Untreated		Champion	56.7	14.5	28.8	903 qts. per acre				
	Sulphur	5/6, 5/12, 5/19	Champion and Doris	58.5	14.7	26.8	1,313 qts. per acre	481.5 qts.	$38.52		
	Arsenate of lead	5/6, 5/12, 5/19	Doris	71.2	15.8	13.0	1,106 qts. per acre	343 qts.	$27.44		
	Untreated		Doris	57.5	15.5	27.	760 qts. per acre				

constituent substances, and this, it is thought is due to the more complete coating effected by the mixture because of its better flowing qualities. The one to five mixture is equally as good as the one to one and much less expensive.

The increase in crop obtained by the applications is about 200 per cent. In the other tests the increase ranged from barely perceptible when the bud cutting on the check was low to more than 100 per cent when it was high.

The returns at Cologne, while larger than those obtained elsewhere, are due to the maintenance of a more complete coating of the buds during the critical period, and should be susceptible of being duplicated or bettered when sufficient care and intelligence are employed.

LITTLE KNOWN WESTERN PLANT LICE. II

By W. M. DAVIDSON, *U. S. Bureau of Entomology, Walnut Creek, Cal.*[1]

Vacuna dryophila Schrank (?). Figs. 16, 1 to 3.

Chaitophorus sp. Davidson, JOUR. ECON. ENT., Feb., 1914, p. 128.

The apterous vivipara (erroneously thought at the time to be the stem mother) and young sexual were described by me in 1914 under the name of *Chaitophorus* sp., the young sexual somewhat resembling the spinous dimorphic forms found in the *Chaitophorinæ* in species living on maple and box elder. However, after other forms had been encountered it became obvious that the species was widely separated from *Chaitophorus*, and that it belonged to a small group in which the sexes are small and wingless and in which the true female deposits normally but one winter egg. In their sexual characteristics the *Vacuninæ* approach the *Schizoneurinæ* and *Pemphiginæ* but the habits of the other forms more nearly approach those of the *Chaitophorinæ* and the *Lachninæ*.

In the species with which we are concerned the stem mothers hatch about the beginning of March, at a time when the buds of the oak have not perceptibly swollen. The lice feed at the base of a bud and are at first dark olive green with erect white spines. As they grow they become darker and mature individuals are brown. They remain at the base of the bud and produce a generation of young which become apterous viviparæ and in turn give birth to the third generation. Some of the third generation become nymphs and later acquire wings. The second and third generation apteræ are bright green with antennæ and legs pale hyaline greenish white. The pupæ are similar in color

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and have in addition, at the base of the abdomen, two pairs of conspicuous yellow areas. The second generation matures about the second week in April and the third generation about the beginning of May. The nymphs are apparently not abundant and the single winged specimen I have collected may be described as follows:

Head, thorax, scutellum, sternal plates dark olive green, shining; antennæ and legs pale yellow hyaline, the two basal antennal joints dark olive green as the head; eyes red, compound; prothorax, wing insertions, abdomen yellowish-green; cornicles brown; cauda pale green; wing veins brown, narrowly bordered dusky; beak pale, apical third dusky; head evenly rounded in front as in apteræ; eyes and ocelli prominent. At the base of each antenna, intad, on the margin of the head is an acute pale tubercle of about the size of the central ocellus. Antennæ about half the body in length, 5-jointed, III sub-equal to IV and V combined; beak reaches third coxæ; thoracic lobes partly fused; wings carried horizontal, third discoidal vein unbranched in one wing and with a branch at apex in the other; hind wing with one discoidal; cornicles pore-like; cauda small, globular; abdomen robust. Measurements (balsam mount); length body .75 mm.; width body .36 mm.; antennæ .39 mm. Date of collection, May 16, 1915.

The above-described individual was submitted to Mr. A. C. Baker, U. S. Bureau of Entomology, Washington, D. C. Mr. Baker has pointed out the following differences between it and European specimens of *V. dryophila* in the U. S. National Museum collection: Typical *dryophila* has four circular sensoria and about 12 prominent hairs on antennal III, while the California specimen has no sensoria and not over 3 hairs; the thorax of typical *dryophila* is without any indication of lobes, whereas the California individual has the thorax partly divided into lobes.

The spring colonies of apteræ are greedily attended by ants and from their very gregarious habits fall easy prey to predators. After May the only forms remaining are the young sexuals which are deposited by the alatæ of the third generation during May. The spring colonies feed both on the stalks and on the lower leaf surface but the sexes only in the latter location. The sexuals are often quite abundant and are not so gregarious as the spring forms. Although deposited in May they do not cast their first skin until September and are not mature until the latter part of November.

The full-grown insects are of a pale lemon color with greyish antennæ and legs, and the cornicles appear as brown-rimmed pores. They are armed with thick spines. The eyes are simple, of 3 facets. The last antennal joint is markedly longer than the penultimate and about as long as III. It bears a fringed sensorium. The beak reaches to the second coxæ. The male measures about .51 mm. by .23 mm., antennæ .21 mm., the female about .85 mm. by .44 mm., antennæ .23 mm. After mating the female deposits a single egg in the axils of the buds. This egg is oval, black, lightly covered with silvery filaments previously noticeable on the sides of seventh and eighth abdominal segments of the female.

This species I have observed at Walnut Creek, Calif., on the valley oak (*Quercus lobata* Née) from the spring of 1913 to 1916. The insect is quite local and does not appear to spread appreciably, perhaps due to the scarcity of alates. In California there is a species on alder (*Alnus rhombifolia* Nutt.) which apparently belongs to the same group of aphides and of which I have thus far taken only the ovipara (Stanford University, Nov., 1914, and Hopland, Sept., 1915). In color and shape this resembles the oak species but it has a different arrangement and structure of spines.

Callipterinella annulata Koch. Figs. 16, 4 to 8.

Chaitophorus annulatus Koch. Die Pflanzenlausen.
Chaitophorus betulæ Buckton. Brit. Aphid. II.
Chaitophorus betulæ (Buckton) Gillette. JOURN. ECON. ENT., Aug., 1910.
Callipterinella annulata (Koch) Van der Goot. Zur Systematik der Aphiden. Tijd. voor Ent., 1913.

Considerable doubt has arisen about the placing of this species and in 1913 Van der Goot erected the new genus Callipterinella to contain it and *Callipterus betularius* Kalt. This latter species I have never seen but *annulata* has characters of *Myzocallis* of the Callipterini (cornicles, antennal armature, etc.) and others of *Thomasia* of the Chaitophorini (cauda, non-capitate hairs, length of antennæ, etc.), but it cannot rightly belong to either. Van der Goot has placed it in the Callipterini which seems its right place, and whether or not his scheme of genera be accepted *in toto* there can hardly be any doubt concerning the validity of the genus *Callipterinella*, as far as the species *annulata* is concerned. The synonymy of Buckton's *betulæ* is taken from Van der Goot.

According to Gillette (J. E. E., Aug. '10) this species has a wide distribution in America for it is reported by him from Portland, Lansing, Albany, Geneva and Denver. In California it occurs together with the European *Euceraphis betulæ* on imported Birch (*Betula alba*) infesting foliage and shoots. The prevailing color is reddish-brown.

APTEROUS VIVIPAROUS FEMALE (Fig. 16, 4). Reddish-brown: body clothed with numerous long non-capitate hairs; many dark brown transverse bands and lateral sub-circular and sub-quadrate areas occur on the dorsum: antennæ basally light-colored, apically dark brown, half as long as the body, clothed with short hairs; III with 4 to 5 oval sensoria in a row on the slightly swollen basal half; hairs on forehead as long as antennal segments I and II combined: legs quite hairy; tarsi dusky, rest concolorous with the body ground color: cornicles dark brown, sub-quadrate, .071 mm. long, .068 mm. wide at base: cauda hardly constricted basally, rounded, dusky, .070 mm. long: anal plate dusky, emarginate: beak stout and short, reaching anterior margin of second coxæ. Length of body 1.83 mm. Width of body (fifth abdominal segment), .71 mm. Antennæ; III .39 mm., IV .20 mm., V .17 mm., VI .10 mm., ilament .19 mm.

OVIPAROUS FEMALE (Fig. 16, 5). Light reddish-brown: body clothed with numerous long non-capitate hairs: head, prothorax and a broad transverse band on each of the remaining body segments dark brown; each of these segments has also a pair of lateral sub-quadrate brown areas, noticeably large on mesothorax, metathorax, and abdominal segment 8: antennæ about half as long as the body, dark brown, basal seven-eighths of III and basal half of IV pale yellow; III thickened basally and on this swollen portion are 3 to 5 oval sensoria in a row: legs dark brown, base of femora and middle part of tibiæ pale yellowish-brown; legs hairy: under side of abdomen marked with rows of small faint brown spots: beak pale, apex brown; barely reaches second coxæ: cornicles dark brown, subquadrate, .093 mm. long, .082 mm. wide at base; cauda pale reddish brown, obtusely conical, .066 mm. long: anal plate rounded: hind tibiæ bear on their slightly swollen basal half a great number of small circular sensoria: length of body 2.48 to 2.89 mm. Width of body (fifth abdominal segment) 1.07 to 1.22 mm. Antennæ; III .54 mm., IV. 29 mm., V. 21 mm., VI .15 mm., filament .27 mm.

MALE (Fig. 16, 6–8). Ground color reddish brown. The single specimen I have is almost destitute of hairs except on the legs and at the extremity of the body: brownish transverse bars, not reaching margins, occur on disk of abdomen and spots of similar color occur on lateral margins: abdominal segments 1 to 5 have 2 pairs of small lateral tubercles, the inner pairs the larger: antennæ almost as long as body; on both there are 17 circular sensoria on III and these occupy in a row the entire length of the joint; V and VI have each an unusually large apical sensorium and VI has besides about 3 small ones; the sensoriation similar to that of the male of *Calaphis betulaecolens* Fitch in that the fourth joint is unsensoriated: beak reaches halfway between second and third coxæ: veins of the wings thick and somewhat narrowly clouded; stigmatic vein obsolete for its basal half: legs with short hairs: cornicles dusky brown, subquadrate, .07 mm. long: cauda rounded, slightly constricted basally, grey: anal plate emarginate: length of body 1.92 mm. Width, maximum .73 mm. Antennæ; III .52 mm., IV .29 mm., V .24 mm., VI .12 mm., filament .24 mm.

Male and apterous female taken the first half of October, 1913, at Oakland, Cal. Oviparous females taken October 23, 1915, at Walnut Creek, Cal.

Aphis neo-mexicana CRll. var. *pacifica* var. nov. Fig. 16, 9 to 14.

ALATE VIVIPAROUS FEMALE (Fig. 16, 9–11). Light green: head and prothorax olive-grey: antennæ black: thorax brownish-olive: cornicles and cauda light grey: beak pale, tip black: abdomen light green with lateral rows of circular black spots: veins of wings brown, narrowly clouded; stigma and insertions greenish: legs yellowish-brown, tibial and femoral apices and tarsi black: sterna black: anal plate grey: eyes dark red. Antennæ not on frontal tubercles, reaching to the fifth abdominal segment; filament longer than III; IV and V sub-equal; sensoria circular, of irregular size and those on III not disposed in a row, 11 to 14 on III, 4 to 6 on IV, usual apical on V and VI except that occasionally on V there are 1 or 2 extra about the middle of the segment: prothorax bears a pair of lateral tubercles: beak reaches to third pair of coxæ: second fork of third discoidal vein slightly nearer to the wing apex than to the first fork: seventh abdominal segment bears a pair of lateral tubercles: cornicles imbricate, slightly enlarged at base, longer than antennal joint IV but not as long as III: cauda of the usual shape of the genus, rather large, two-thirds the cornicles in length, armed with spines. Length of body 1.2 mm. to 1.3 mm. Maximum width .46 mm. to .56 mm. Wing expanse about 5 mm. Beak .46 mm. Cornicles .17 mm. to .2 mm.

Cauda .14 mm. Antennæ; III .21 mm. to .26 mm., IV .14 mm. to .17 mm., V .14 mm. to .17 mm., VI .11 mm. to .12 mm., filament .27 mm. to .31 mm.

APTEROUS VIVIPAROUS FEMALE (Fig. 16, 12–14). Light green: antennæ, legs, cornicles, cauda hyaline greenish white; knees briefly and antennal VI$_b$ entirely, dusky grey; eyes red: prothorax with prominent lateral tubercles: a pair also on seventh abdominal segment: beak pale, apex dusky, reaching beyond second coxæ. Length of body 1.23 mm. Width .67 mm. Cornicles .27 mm. Cauda .19 mm. Antennæ; III .16 mm., IV .14 mm., V .13 mm., VI .11 mm., filament .21 mm. The pupa is pale green with light-colored wing-pads.

This species was taken at Walnut Creek, Cal., curling terminal leaves of cultivated red currant in June, 1915. What appears to have been the same species was collected at San Jose, Cal., in May, 1912, on the same host. Mr. A. C. Baker, Washington, D. C., to whom specimens were sent, compared these with the type of *A. neo-mexicana* Ckll. and has written that the two varieties are very similar except that the California specimens have a longer distal antennal joint and slightly larger sensoria. The species is evidently near *Aphis sanborni* Patch and *Aphis ribis* Sanborn. It differs from the former in the comparative lengths of antennal joints and cornicles and from the latter in its comparatively longer beak and in the sensoriation. The infestation at Walnut Creek was confined to a single small currant bush and was first noticed about the end of May. Before the end of July the lice had been entirely wiped out by predators. Late in the fall a few oviparæ of a species of *Aphis* were observed on the bush, but the species could not be identified. At the same time migrants and sexes of *Myzus cynosbati* Oestlund occurred on the plant.

Type: U. S. National Museum Catalogue No. 20072.

Myzus ribifolii sp. nov. Fig. 16, 15 to 28.

STEM MOTHER (Fig. 16, 15, 16). Stout and broad; ground color pale green; head, band of prothorax, thorax, and disk of abdomen brownish-black; the lateral margins of the abdomen and that part of the disk caudad of the cornicles (except a median band on seventh segment) pale green; the dark color predominates; under side of body pale green; cornicles, tip of cauda, coxæ, trochanters, knees, tibiæ and tarsi dark brownish-black; antennæ pale green, articulations dusky brown: antennæ on obvious frontal tubercles which are slightly gibbous; first joint rather obscurely toothed; antennæ from half to two-thirds the length of the body; III longer than the filament of VI, but shorter than whole of VI; V slightly exceeding IV; beak pale, tip dusky, reaches to second coxæ: cornicles imbricated for their entire length, slightly thickened at base: cauda slightly shorter than cornicles, ensiform, the apex rather bluntly rounded: hairs on forehead and antennæ long, those on body and legs shorter, in all places moderately abundant, very indistinctly capitate. Length of body 2.13 mm. Width (metathorax) 1.30 mm. Cornicles .21 mm. Cauda .19 mm. Beak .50 mm. Antennæ; III .27 mm. to .29 mm., IV .16 mm., V .17 mm., VI .09 mm., filament of VI .23 mm.

Stem mothers were collected at Redwood Canyon, near Walnut Creek, Cal., towards end of March, 1915, in curled and blistered foliage

of the wild flowering currant (*Ribes glutinosum* Benth.). In most of the curled leaves but one insect occurred and it is presumable that a single individual was able to bring about the malformation. The leaves bore noticeable yellow and pink blisters recalling those caused by *Myzus ribis*.

APTEROUS VIVIPAROUS FEMALE, second generation (Fig. 16, 17–19). Yellowish-green in ground color, marked very much as is the stem mother, but some individuals lack the dark brown markings and have only orange-colored areas about the base of the cornicles; antennæ basally pale, apically dark brown; cornicles and cauda brownish-black; coxæ and tibiæ dark brown; 4 anterior femora greenish-yellow posterior femora black, the basal half greenish-yellow; tarsi dark brown; antennæ reach to base of cornicles, relatively longer than those of the first generation but similar in structure; III bears on its basal half 4 to 7 sensoria; IV is longer than V; III and filament of VI sub-equal: cornicles and cauda much as in stem mother shape of former variable as base is sometimes constricted and at other times widened: beak reaches third coxæ: hairs as in stem mother. Length of body 1.96 mm. to 2.13 mm. Width (metathorax) .97 mm. to 1.07 mm. Cornicles .21 mm. to .24 mm. (average .23 mm.). Cauda .20 mm. Beak .53 mm. to .57 mm. Antennæ; III .33 mm. to .37 mm., IV .19 mm. to .23 mm., V .19 mm. to .21 mm., VI .07 mm. to .09 mm., filament of VI .33 mm. to .34 mm.

Taken during March, April and May, 1914 and 1915, in curled leaves.

ALATE VIVIPAROUS FEMALE (Fig. 16, 20–22). Apple green; head, thorax, antennæ, cornicles, apex of cauda, black or dark brown; legs yellowish-green; apical half to two-thirds of femora, tibiæ and tarsi, blackish; base of antennal III pale; transverse rows of dark brown spots occur on disk of abdomen and lateral spots are sometimes present: Antennæ longer than the body, their structure as in stem mother, III with from 29 to 35 tuberculate circular sensoria the whole length of joint, V and VI with usual apical sensoria; hairs numerous, about equal in length to the width of the joints: eyes dark red: beak reaches third coxæ: wings as in *Myzus;* stigma and insertions light green; first and second discoidals narrowly clouded; second fork of third discoidal nearer wing apex than first fork: legs rather long and narrow: cornicles as in stem mother but considerably longer and not thickened basally: cauda as in apterous forms: hairs of body are longer than in the apterous forms. Length of body about 1.60 mm. Width (mesothorax) .67 mm. to .69 mm. Cornicles .25 mm. to .27 mm. Cauda .20 mm. Beak .57 mm. Wing expanse 6.57 mm. to 6.66 mm. Antennæ; III .59 mm. to .66 mm., IV .33 mm. to .36 mm., V .30 mm. to .35 mm., VI .08 mm. to .10 mm., filament of VI .50 mm. to .57 mm.

Collected with apterous forms during March, April and May, 1914 and 1915.

OVIPAROUS FEMALE (Fig. 16, 23–26). Pale whitish-yellow; eyes bright red; the dark markings of the viviparous forms appear very faintly on the dorsum of the body in the ovipara; coxæ, cornicles and cauda light grey; tarsi grey; joint VI of antennæ grey, rest pale: antennæ half the body in length; joint III with 3 to 4 circular sensoria on basal half; V and VI with usual sensoria; V slightly longer than IV; filament of VI longer than III; frontal tubercles as in other forms; hind tibia is dilated for its basal half and bears about 26 sensoria on this portion: cornicles and cauda as in alate

female but shorter. Length of body 1.64 mm. to 1.80 mm. Width (third abdominal segment) .83 mm. to .90 mm. Cornicles .20 mm. Cauda .15 mm. to .17 mm. Beak .40 mm. Antennæ; III .25 mm. to .26 mm., IV .13 mm. to .14 mm., V .14 mm. to .15 mm., VI .07 mm., filament of VI .26 mm. to .29 mm.

Collected in curled foliage May 7, 1914.

Male pupa. Brick red; wing-pads whitish. Taken May 7, 1914.

MALE (Fig. 16, 27, 28). General color red; head, thorax, cornicles, cauda, sterna, black; antennæ black, base of III light red; legs pale yellowish-red, knees broadly, tarsi, apical half of tibiæ, black; stigma and insertions of wing light green; veins black, discoidals I and II narrowly clouded and thickened; eyes dark red: antennæ much longer than body, on obvious frontal tubercles; II obtusely toothed; filament of VI longer than III; IV longer than V; sensoriation III 40 to 44 circular tuberculate the whole length of joint, IV 10 to 12 dispersed throughout joint, V 8 to 14 (besides apical) disposed as on IV, VI 1 to 2 besides apical group: cornicles imbricated, cylindrical: cauda ensiform: beak reaches third coxæ, pale, apex dusky: legs long and narrow: abdomen red, with lateral brown spots and faint brown markings on disk: whole body clothed with hairs, of which there are several rows. Length of body 1.32 mm. to 1.54 mm. Width (mesothorax) .58 mm. to .60 mm. Cornicles .18 mm. to .19 mm. Cauda .16 mm. Expanse of wings 5.40 mm. Beak .49 mm. Antennæ; III .59 mm. to .64 mm., IV .30 mm. to .40 mm., V .27 mm. to .36 mm., VI .08 mm. to .11 mm., filament of VI .63 mm. to .68 mm.

Type: U. S. National Museum Catalogue, No. 20073.

Taken in curled foliage May 20, 1913, and May 7, 1914.

I have never located any winter eggs. The aphids are not to be found after the month of May and so I conclude that the winter eggs are deposited in this month and that they do not hatch until the spring following. The stem mothers must hatch as early as February as I have collected mature second generation individuals in the last week of March.

EXPLANATION OF FIGURE 16

1–3. *Vacuna dryophila* (?). 1: Alate viviparous (?) female, head and antennæ 2: Male. 3: Oviparous female, and last antennal joint (enlarged).

4–8. *Callipterinella annulata*. 4: Apterous viviparous female. 5: Apterous oviparous female, antenna. 6–8: Male. 6: antenna. 7: wing. 8: cornicle.

9–14. *Aphis neo-mexicana* var. *pacifica*. 9–11: Alate viviparous female. 9: antenna. 10: cornicle. 11: cauda. 12–14: Apterous viviparous female. 12: antenna. 13: cornicle. 14: cauda.

15–28. *Myzus ribifolii*. 15, 16: Stem mother. 15: antenna. 16: cornicle. 17–19: Apterous viviparous female. 17: head and antenna. 18: cornicle. 19: cauda. 20–22: Alate viviparous female. 20: antenna. 21: cornicle. 22: cauda. 23–26: Oviparous female. 23: antenna. 24: cornicle. 25: cauda. 26: hind tibia. 27, 28: Male. 27: antenna. 28: cornicle.

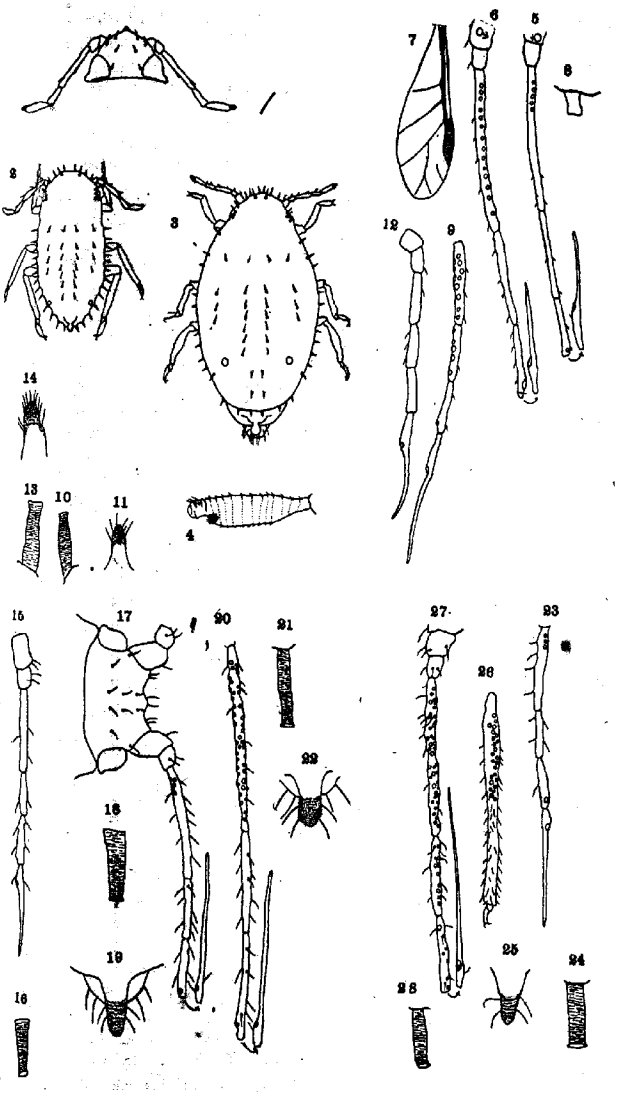

Fig. 16, see explanation on opposite page.

Scientific Notes

The Angoumois grain moth (*Sitotroga cerealella* Oliv.) **is the subject of much complaint, especially in Pennsylvania, in York county, injury being chiefly to wheat.**

Wanted: Specimens of Œstridæ. Dr. C. H. T. Townsend has under way a special study of the Œstrid flies. He is especially desirous of obtaining specimens of the larvæ of any species of *Cephenomyia* which, as is well known, are found more or less commonly in the nasal passages of deer. It is requested that the Bureau agents obtain specimens of these larvæ either themselves or through friends for Dr. Townsend's work.

An Illustration of the Importance of Quarantine against Injurious Insects. Early in 1914, Mr. E. C. Green, an American engaged in the encouragement of cotton culture by the Brazilian government, made a careful survey of the cotton belt of Brazil. He was looking especially for the boll weevil and the pink bollworm. Neither insect was found in the course of considerable travel and extensive examinations of seed. Late in 1916 Mr. Green made another trip over the same territory and found that the pink bollworm was generally and thoroughly established. The way in which the insect was introduced is clear: In 1913 the Brazilian government agitated the cultivation of Egyptian cotton in that country. An agent was sent to Egypt and large quantities of seed were shipped to Brazil. No precautions were taken as to the seed obtained, and it was all admitted to Brazil without fumigation or other treatment. The Brazilian goverment has inspectors located in every state capital. The seed was distributed to these inspectors and in turn by them to local representatives. This was probably as thorough a method of desseminating an insect as is possible. The Brazilian government now realizes what has been done and various senators seriously consider an enactment requiring the burning of all the cotton fields in the Republic.

Monthly Letter, Bureau of Entomology, February, 1917.

Controlling the Cottony Cushion Scale in New Orleans. The November *Monthly Letter* of the Bureau of Entomology gives a short account of a citizens' meeting at Tulane University in New Orleans to consider a campaign against the cottony cushion scale. The committee appointed by the president of the Academy of Sciences, under whose auspices the meeting was called, presented the matter to Mayor Behrman of New Orleans, Director Dodson of the Experiment Stations, and Mr. Alexander, in charge of the State Conservation Commission, and urged sufficient appropriations for a campaign in rearing and distributing the Australian lady beetle, *Novius cardinalis*. The result was that the city commission agreed to contribute $2,500 in cash and move a greenhouse from a property recently purchased to a convenient situation for the winter rearing of the lady beetles. Professor Dodson, for the Experiment Stations, contributed $500 and an equal amount was obtained from the Conservation Commission, while the State Government appropriated $2,500, making available the total sum of $6,000. The greenhouse has now been erected at the Sugar Experiment Station in Audubon Park; which seemed the most suitable place for the work. The rearing of the lady beetles was begun last summer by Mr. E. R. Barber, and is still in his hands, an appeal having been made for an expert by Mayor Behrman to Doctor Howard and Secretary Houston. Specimens of *Novius* have been obtained from Mr. Harry S. Smith in California and Mr. A. C. Mason in Florida, as well as scales infested with *Cryptochætum* (*Lestophonus*) *monophlebi* from Mr. Smith. Several colonies of lady beetles have been started, and with the aid of the greenhouse many thousands should be obtained in the near future.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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Our country has entered a gigantic struggle in which material assets of many kinds play a most important part. There is urgent need for the conservation and development of all resources—life, health, food—to designate a few having a close relation to applied entomology. An army or navy can accomplish little without the foregoing essentials. There are many openings for the economic entomologist to demonstrate the utility of his calling. The urgent need of better camp sanitation, so far as insects are concerned, warrants an entomological staff attached to every large camp and hospital center and associated with the medical or sanitary corps in handling insect problems, particularly flies and other disease carriers, though body parasites and animal pests should not be ignored. These men should have a rank which would give weight to their recommendations, resources which would permit intensive studies of the entire problem if necessary, and facilities for the practical application of results to field and camp conditions. The work in the various localities should be coördinated and directed by a supervising entomologist in order to ensure the greatest efficiency.

It falls to the economic entomologist more than anyone else to advise and urge the adoption of measures which will minimize the effect of insect ravages, especially upon staple crops. Dr. Howard, of the Bureau of Entomology, is organizing his forces to bring before the country at large information of immediate value in insect control, and now seeks the coöperation of American entomologists on reporting unusual insect outbreaks. Observers in the southern portions of the country

can render material aid in reporting the abundance of pests, especially those likely to be injurious a little farther north. Warnings of this nature, particularly if distributed to entomologists who could investigate local conditions and appraise possibilities, would be of immense service in preventing extensive injuries. The staple crops should receive special attention in a serious effort to forecast, and so far as possible forestall, insect depredations. The economic entomologist is called upon all too frequently after the remedial stage has passed. Here is an opportunity, which may not come again for a generation or more, to make more general a system of intelligent prognosis which would result in adoption of preventive rather than remedial measures.

Reviews

Guide to the Insects of Connecticut, Part III. The Hymenoptera or Wasp-Like Insects of Connecticut. By H. L. VIERECK AND OTHERS. Bulletin 22, State Geological and Natural History Survey. (George S. Godard, State Librarian, Hartford, Conn. $2.00.)

This work of 824 pages and 10 plates is the only general presentation of the Hymenoptera as a group, which has appeared for many years in this country, and though restricted to a single state will nevertheless be of wide application, as in Connecticut the Transition and Upper Austral areas both occur.

Prepared by Mr. H. L. Viereck with the collaboration of such entomologists as A. D. MacGillivray, C. T. Brues, W. M. Wheeler and S. A. Rohwer, the work represents all the recent progress in our systematic knowledge of this order, in fact to a somewhat discouraging degree for those who look for the genera Pimpla, Bombus and many of the other old "standbys" in vain. Progress in this line, however, must probably be through a seemingly chaotic period, and the sooner this comes and has been traversed, the better.

Keys from the superfamilies all the way to the species are provided, together with data as to dates and places of capture in the state, food or host, and occasionally other items are given. In addition, species not as yet actually taken in the state but probably present there are included. New species are described, making the book not only a list and key but a necessary place of reference for original descriptions, some of which, unfortunately, are extremely brief.

Minor errors are too numerous in the book, and to distinguish half a dozen species in an analytical key by differences in length of body of one millimeter in a total length of from eight to twenty millimeters is at least doubtful, but the value of the book as a whole is such that many errors can easily be forgiven, bearing in mind the amount of ground it was necessary to cover. The plates are excellent in their way. (*Adst.*).

H. T. F.

Current Notes

Conducted by the Associate Editor

Mr. Emery A. Proctor, Gipsy and Brown-Tail Moth Investigations, Bureau of Entomology, died December 11, 1916.

According to *Science*, Dr. B. R. Poppius, the Finnish entomologist, died November 27, 1916, at the age of forty years.

Dr. L. O. Howard gave a lecture, February 1, before the Washington Academy of Sciences, on "The Carriage of Disease by Insects."

Mr. C. O. Waterhouse, for many years assistant keeper of the British Museum, died on February 4, at the age of seventy-three years.

Recent resignations from the Bureau of Entomology are as follows: Oswald D. Ingall and Charles F. Guptill, Gipsy and Brown-Tail Moth Investigations.

Professor W. C. O'Kane, Durham, N. H., attended the annual meeting of the New England Nurserymen's Association at Hotel Taft, New Haven, Conn., January 30-31.

Dr. Edith M. Patch, entomologist, Maine Agricultural Experiment Station, Orono, Me.; Prof. George A. Dean, state entomologist, Manhattan, Kan.; Prof. Georges Maheu, provincial entomologist, Quebec, Can., visited the Bureau of Entomology during February.

During the month of January the following were visitors at the Bureau of Entomology: C. Gordon Hewitt, Ottawa, Can.; G. A. Dean, Manhattan, Kan.; E. D Ball, Madison, Wis.; and Prof. James G. Sanders, Harrisburg, Pa.

According to *Science*, the governor of Minnesota has recommended to the legislature that $25,000 be appropriated for the use of the state entomologist in combating the white-pine blister rust in Minnesota.

Dr. Alvah H. Peterson, whose New Jersey appointment was noted in the February issue of the JOURNAL, is assistant entomologist of the New Jersey Agricultural College Experiment Station, and instructor in Entomology in Rutgers College.

Mr. P. B. Wiltberger has been appointed instructor in entomology at the Michigan Agricultural College and assistant entomologist of the Station *vice* G. C. Woodin resigned, the appointment to take effect April 1.

Recent appointments to the Bureau of Entomology are as follows: Carl F. W. Muesbeck, scientific assistant, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass; J. E. Graf, Truck Crop and Stored Product Insect Investigations, Plant City, Fla.

Dr. Marcus T. Smulyan, formerly connected with the Virginia Agricultural Experiment Station, has been appointed to the position of Specialist in Insects and Carriers of Insect Diseases, Bureau of Entomology, and assigned to duty at the Gipsy Moth Laboratory, Melrose Highlands, Mass.

The offices of the Gipsy and Brown-Tail Moth Investigations, Bureau of Entomology, were moved in December from 43 Tremont Street, Boston, to 964 Main Street,

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The Index of American Economic Entomology by Dr. Nathan Banks is ready for distribution. Orders may be placed with A. F. Burgess, Melrose Highlands, Mass. See advertisement for rates.

Melrose Highlands, near the laboratory. The Inspection and Quarantine Service still continues its office at the Boston address.

Professor W. C. O'Kane, Durham, N. H., recently published a new book, entitled, "Jim and Peggy at Meadowbrook Farm." Its purpose is to convey to city children a picture of everyday farm life; it is profusely illustrated with New Hampshire scenes, and is published by the Macmillan Company.

Mr. Edmund Baynes Reed, one of the pioneer entomologists of Canada, died at Victoria, B. C., November 18, 1916, in the seventy-ninth year of his age. Mr. Reed was interested in both systematic and economic entomology, and was one of the original members of the Entomological Society of Ontario when it started in 1863.

Dr. E. F. Phillips, Bureau of Entomology, attended the following meetings during the months of January and February: Kentucky State Beekeepers' Association, Lexington, Ky., January 4; North Carolina Beekeepers' Association, Winston-Salem, N. C., January 11; Colorado Beekeepers' Association, Fort Collins, Col., January 18 and 19; National Beekeepers' Association, Madison, Wis., February 6-8.

The following transfers have been made in the Bureau of Entomology: D. A. H. McCray, from Bee Culture to Insects Affecting the Health of Man, to be established at New Orleans, La.; T. C. Barber, from Southern Field Crop Investigations to the Federal Horticultural Board, to be stationed at San Antonio, Tex.; W. H. Larrimer, Charleston, Mo., to West Lafayette, Ind.; Julian J. Culver, Gipsy Moth Laboratory, to Deciduous Fruit Insect Investigations, stationed at Fort Valley, Ga.

Dr. L. O. Howard left Washington on the fifth of February, and visited the field station at Orlando, studying with Mr. W. W. Yothers the effects of the freeze of February 3 on the orange crop and the orange trees and on the insects of the orange. He also consulted with Mr. J. E. Graf, who has established a station at Plant City; and later visited Thomasville, Ga., where Mr. George D. Smith is studying cotton insects, stopping at Atlanta on his return to Washington for consultation with Mr. E. L. Worsham concerning coöperative work in Georgia.

The completion of the Carnegie Institution "Monograph of the Mosquitoes of North and Central America and the West Indies" is in sight! The final proofs, including the index to the last volume, have been read, and the Institution believes that the final volume will be ready for distribution about April 15. It is of interest to note that the indices to Volumes 3 and 4 are combined in Volume 4, Volume 3 carrying no index. The pagination of Volumes 3 and 4 is continuous.

The Federal Horticultural Board has had a thorough survey made by its California collaborators, under the direction of Mr. Maskew, of the department's introduction gardens at Chico, Cal. This survey is an annual function and precedes the shipment of plant material from this garden. A similar survey is in progress in relation to the introduction gardens in Florida, notably the garden at Miami, and involves inspection of plants both for insect pests and fungous diseases. Various entomological and pathological experts of the Board, including members of the Board, were in attendance during the month of January at important conferences in New York over quarantine matters, particularly in relation to the blister rust, in connection with the entomological and pathological meetings held in that city, and with the International Forestry Congress held at Washington. At the latter Congress the chairman of the Board presented an address on the subject of losses occasioned by introduced insect pests and plant diseases. As a result of these conferences and of the needs of the plant quarantine service, an effort will be made to amend the Plant Quarantine Act, broad-

ening its powers in relation to domestic quarantines so that introduced pests of a fairly widespread character, like the blister rust and the alfalfa weevil, can be more effectively controlled.

Professor Raymond C. Osburn of the Connecticut College for Women, New London, Connecticut, has been elected head of the Department of Zoölogy and Entomology of the Ohio State University, his appointment to take effect July 1. He will assume the duties carried during the last nineteen years by Dr. Herbert Osborn, who was last year elected Research Professor and who will hereafter give his entire time to research work, including the direction of research work by graduate students, and, for the present, the directorship of the Lake Laboratory and of the Ohio Biological Survey. Dr. Osburn graduated from the Ohio State University in 1898, received the master's degree from the same institution in 1900 and the Ph. D. degree from Columbia in 1906. He has been connected as a teacher with the Starling Medical College, Columbus, Ohio; Fargo College, Fargo, N. D.; Clinton High School of Commerce, New York City; Barnard College, Columbia University, and the Connecticut College for Women, in which he is now Professor of Biology. He is perhaps best known to entomologists as the author of a number of papers on Syrphidæ and Odonata and as recently President of the New York Entomological Society. While his own investigations may deal largely with other forms, especially aquatic groups of invertebrates and fishes, entomologists may feel assured that he will give full support to the entomological work and especially to the lines of applied entomology which have been a prominent part of the work in the Ohio institution.

The Third Annual Meeting of Entomological Workers of Ohio was held at Ohio State University on February 2, 1917, with thirty members in attendance. The program consisted of reviews of projects and reports on investigations of members of the Ohio Experiment Station, the State Division of Orchard and Nursery Inspection, and the Department of Entomology of the University. The following program was presented:

Distribution of Ohio Broods of Periodical Cicada with Reference to Soil. H. A. Gossard.

General Reports from Heads of Department Organizations: H. A. Gossard, Ohio Experiment Station; N. E. Shaw, State Division of Orchard and Nursery Inspection; Herbert Osborn, Department of Zoölogy and Entomology, Ohio State University; H. A. Gossard, Review of Projects; J. S. Houser, Review of Projects; W. H. Goodwin, Review of Projects; R. D. Whitmarsh, Review of Projects; D. C. Mote, Review of Projects; J. L. King, Review of Projects; Richard Faxon, Nursery Imports; F. D. Heckathorn, Winter Work in Nurseries and Surroundings; H. E. Evans, An Inspector's Itinerary for a Year; H. J. Speaker, Report of Control of Gipsy Moth Outbreak; C. L. Metcalf, Predaceous Insects; C. J. Drake, Notes on Aquatic and Semi-Aquatic Hemiptera of Ohio; Herbert Osborn, Problems with Meadow Insects; T. L. Guyton, Aphididæ of Ohio.

A permanent organization was effected and the following officers elected for 1917–18: N. E. Shaw, Chairman; J. S. Houser, Secretary.

A special appropriation of $50,000 has been requested in relation to the possible invasion of Texas by the pink bollworm, this money to be expended by the Federal Horticultural Board in coöperation with the Bureau of Entomology in quarantine border control, and control in Texas in particular relation to the various cotton mills which have received considerable quantities of seed from Mexico for milling purposes during the year. T. C. Barber has been transferred from the branch of Southern Field Crop Insect Investigations to the Federal Horticultural Board and was placed

in field charge of this work, effective February 1. An inspection service will be organized, consisting of at least four persons, two of whom will be assigned at once to border control work, and the other two to act in conjunction with Mr. Barber in the interior service and control. The continued disturbed condition in Mexico has frustrated the attempt to make a direct survey of the infested region in Mexico, and the negotiations for permission to make and safeguard such survey, conducted through the Mexican Ambassador Designate and the State Department have so far been unsuccessful.

Mr. John F. Strauss, connected with the Bureau of Entomology since 1903, died on Tuesday, January 2, 1917, at the Pottenger Sanatorium, Monrovia, Cal. After leaving the public schools, Mr. Strauss spent one year in the Kansas State Agricultural College, came East and entered the Virginia State Agricultural College, where he completed a four years' course in Agriculture, receiving the degree of Bachelor of Science. After graduation he took up the study of medicine, spending two years at the University of Virginia, completing the courses in comparative anatomy, histology, and bacteriology. He did not further pursue his medical studies, but returned to the Virginia Polytechnic Institute in the fall of 1897, pursuing graduate work and receiving the degree of Master of Science. Subsequently Mr. Strauss was connected with the Virginia Experiment Station and College as laboratory assistant and assistant instructor. Upon entering the Bureau, Mr. Strauss was employed as an entomological draftsman in the branch of forest entomology, working under the direction of Dr. A. D. Hopkins. During his period of service in that branch from 1903–1908, he made many excellent illustrations of forest insects, among which are those illustrating articles on "Insect Injuries to Forest Products" in the Yearbook for 1904, and "Insect Enemies of Forest Reproduction" in the Yearbook for 1905, and "Injuries to Forest Trees by Flathead Borers" in the Yearbook for 1909. After a short assignment as insect artist to the Bureau in general, during which time he prepared illustrations of cotton insects at the Dallas (Texas) laboratory, and illustrations of parasites of the gipsy and brown-tail moths at the Melrose Highlands (Mass.) laboratory, he was transferred to the office of Deciduous Fruit Investigations, with which office he was connected at the time of his death. Mr. Strauss accomplished a large amount of work in the preparation of drawings of deciduous fruit and other insects, illustrating most of the publications that have appeared from that branch since about 1910. Two papers have been published by Mr. Strauss, namely, one on *Clinocoris lectularius* and the other on the grape leaf-folder, *Desmia funeralis*. He was a member of the Entomological Society of Washington. Mr. Strauss possessed a high degree of artistic ability which, combined with his entomological training, made him unusually successful in insect delineation work. He was earnest and thorough, and possessed a personality which endeared him to all who came to know him.—*Monthly Letter* of the Bureau of Entomology.

Solenopsis Interferes with Rearing Experiments in Texas. Mr. D. C. Parman, Bureau of Entomology, writes that he is having very serious trouble with *Solenopsis*. This ant has been a serious obstacle in the way of the rearing experiments at Uvalde, Texas, but according to his reports it is much worse this year than ever before. He says that there is a large bed heavily infested and that tunnels have been traced as far as 150 yards in some directions. I am wondering if any one in the Bureau has had any experience in the control of this ant under such conditions and if so should like to have their experience.

F. C. BISHOPP.

Mailed April 17, 1917.